

**WATER QUALITY OF THE LOWER SAN JOAQUIN RIVER:**  
**LANDER AVENUE TO VERNALIS**  
**OCTOBER 1989 TO SEPTEMBER 1990**  
**(WATER YEAR 1990)**

**California Regional Water Quality Control Board**  
**Central Valley Region**  
3443 Routier Road  
Sacramento, California 95827-3098

**January 1991**



**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD  
CENTRAL VALLEY REGION**

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## SUMMARY

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. The objectives of this monitoring program are:

1. to assess existing water quality conditions;
2. to provide a long-term database for assessing the effects of future regulatory actions;
3. to provide a database to assess potential long-term aquatic ecosystem impacts including in-stream biotoxicity testing being conducted by Regional Board staff; and
4. to provide a database to validate the San Joaquin River Input-Output Model (SJR10-1) described in Appendix C of the State Water Resources Control Board (SWRCB) Order No. WQ 85-1 Technical Committee Report on "Regulation of Agricultural Drainage to the San Joaquin River" which was released in August 1987.

Selected mineral and trace element constituents were measured for total recoverable concentrations at eight monitoring sites along a 60-mile section of the San Joaquin River extending from near Stevinson at Lander Avenue to near Vernalis at Airport Way. Water quality samples were collected on a monthly basis, or at selected sites on a weekly basis, and analyzed for electrical conductivity (EC), boron, chloride, total alkalinity, selenium, and, at selected sites, molybdenum. A previous report has been issued for data collected from May 1985 through March 1988 (James, et al., 1988). A similar report has been prepared for the period 1 October 1987 to September 1988 (Westcot et al., 1989) and for the period 1 October 1988 to 30 September 1989 (Westcot et al., 1990). The present report covers WY 90 (1 October 1989 to September 1990), a fourth critically dry year.

The general trend in constituent concentrations along the San Joaquin River study area during WY 90 continues to be that the lowest concentrations occur at the upstream and downstream study end points; Lander Avenue and Airport Way (Vernalis), respectively. Concentrations were highest just downstream of Lander Avenue below the Salt Slough and Mud Slough (north) confluences at Fremont Ford and Hills Ferry Road, respectively. Salt Slough and Mud Slough (north) are the two major sources of subsurface agricultural drainage to the San Joaquin River. Downstream of the Hills Ferry Road site concentrations decreased as each of the three east side streams diluted the River.

Chloride, boron, sulfate, EC, selenium, and molybdenum values in the river appear to be directly related to climatic and streamflow conditions in the river basin. During the critically dry 1987-90 water years (WYs) constituent concentrations were routinely higher than they were during the wet 86 WY. During WY 90 these same constituents also show seasonal variations in concentrations with the highest levels occurring during the nonirrigation season (October to March).

In December 1988, the Regional Board adopted water quality objectives for the San Joaquin River. These objectives and associated compliance dates were approved by the State Water Resources Control Board in September 1989, the final month of WY 89. The objectives were set for molybdenum, boron and selenium.

Molybdenum water quality objectives are delineated by location on the river; upstream of the Merced River inflow (10  $\mu\text{g/L}$ ) and downstream of the Merced River inflow (19  $\mu\text{g/L}$ ). During WY 90, only one site, Lander Avenue, the single site upstream of the drainage inflows exceeded the water quality objective. The non-compliance is a result of natural conditions and likely the result of the critically dry year. During WY 90, flows at the Lander Avenue site were very low and most flow resulted from ground water seepage.

Boron water quality objectives are delineated by location on the river, season, and water year type. Throughout WY 90, a critically dry year, three sites exceeded their respective approved boron objectives. Two of the sites, the San Joaquin River at Fremont Ford and the San Joaquin River at Hills Ferry, are upstream of the Merced River inflow (objective, 2.0 mg/L). While the third, the San Joaquin River at Crows Landing is downstream of the Merced River inflow (objective 1.3 mg/L). Compliance with these objectives is to begin in 1993.

In addition to water quality objectives, milestones were also set for selenium to assess progress towards meeting the objectives. During WY 90, selenium concentrations in the San Joaquin River at both Hills Ferry and Fremont Ford exceeded both the 1993 objective and the WY 90 milestone for the upstream reach of the river. In the downstream reach of the river, the Crows Landing site exceeded both the objective and milestone although concentrations rapidly diminished farther downstream. Lack of freshwater dilution contributes to the higher concentrations found in the critically dry water years.

Water quality in the San Joaquin River will continue to be evaluated against objectives and milestones in upcoming water years.

## INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. Water quality samples were collected at eight monitoring sites along a 60-mile section of the River extending from near Stevinson in Merced County to Airport Way near Vernalis in San Joaquin County (Figure 1). The purpose of this monitoring program was to compile an ongoing database for selected inorganic constituents found in San Joaquin River water. This database will be used to help assess the effects of agricultural drainage water on the quality of the San Joaquin River. A long-term database is essential to assess the long-term effects of the implementation of regional agricultural drainage reduction programs. This report contains the results of this monitoring program for data collected from October 1989 through September 1990 (WY 90). A previous report has been issued for data collected from May 1985 through March 1988 (James et al., 1988). Follow-up reports have been prepared for Water Years (WY) 1988 (1 October 1987 to 30 September 1988 (Westcot et al., 1989)) and WY 1989 (1 October 1988 to 30 September 1989) (Westcot et al., 1990)). This monitoring program was designed to complement monitoring programs conducted by other state, federal, and local agencies.

## STUDY AREA

The study area consists of the 60-mile section of the San Joaquin River extending from Lander Avenue (Highway 165) near Stevinson to Airport Way near Vernalis. Monitoring sites are located near each of the eight river overcrossings on this section of the River (Figure 2).

There are five major tributaries to the San Joaquin River within this study area: Salt Slough, Mud Slough (north), and the Merced, Tuolumne, and Stanislaus Rivers. Salt Slough and Mud Slough (north) drain the Grassland Area of western Merced County and discharge to the San Joaquin River in the southern portion of the study area (Figure 2). These two sloughs are the major source of agricultural subsurface drainage water discharges to the San Joaquin River. They carry a varying mixture of surface and subsurface agricultural drainage, operational spillage from irrigation canals, and seasonal drainage from duck ponds flooded each winter for waterfowl habitat. The Merced, Tuolumne, and Stanislaus Rivers are east side streams which drain the Sierra Nevada Mountains and contain relatively high quality water.

In addition to the five major tributaries there are also a number of smaller tributaries as well as surface and subsurface agricultural drains that discharge to the San Joaquin River within the study area. A list of significant inflows and their locations, referenced by river mile are listed in Table 1. The monitoring sites are also listed in this table. A full description of the inflow points that occur in this 60-mile section of the River are in James, et al. (1989).

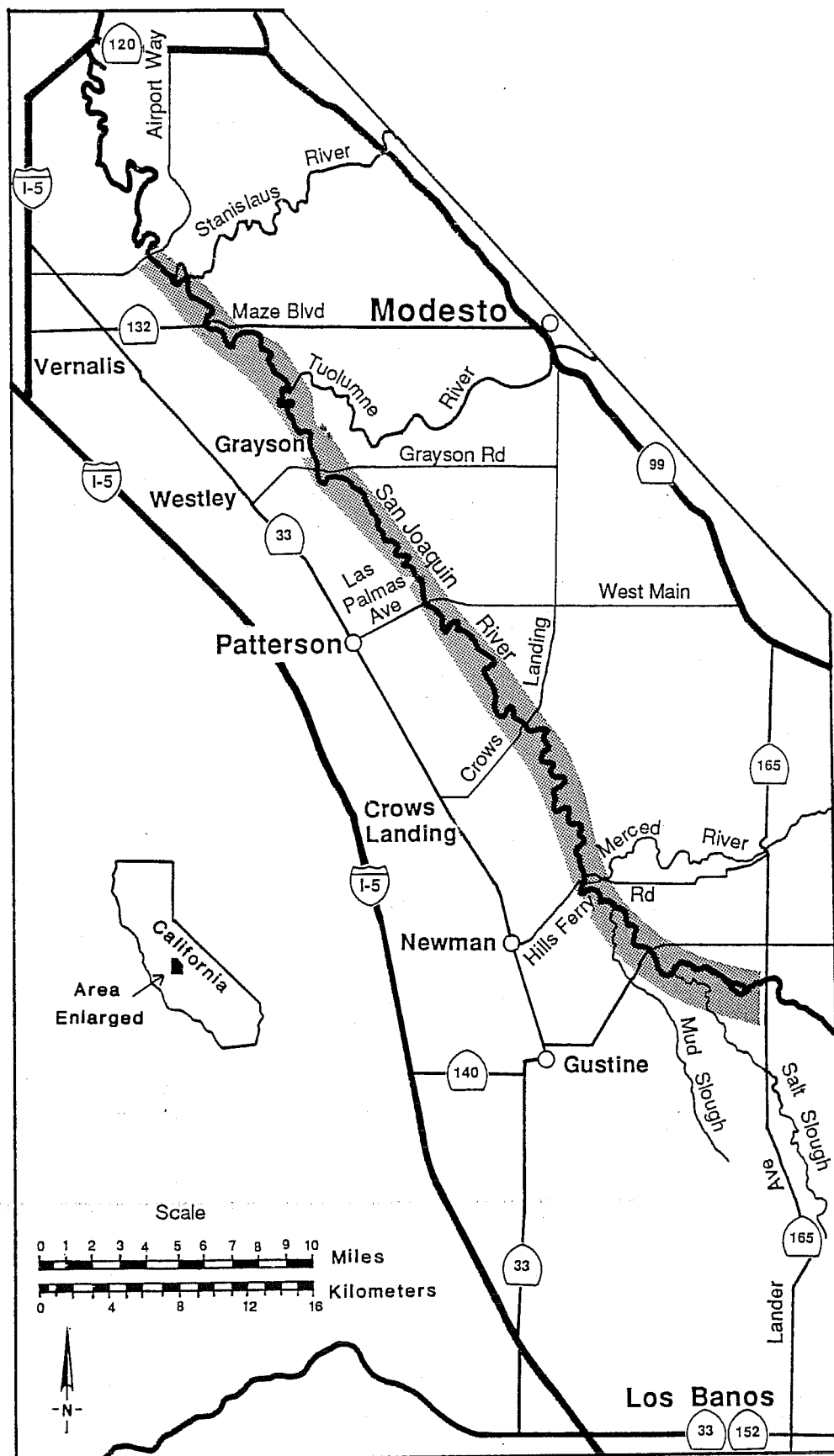


Fig. 1 Location Map

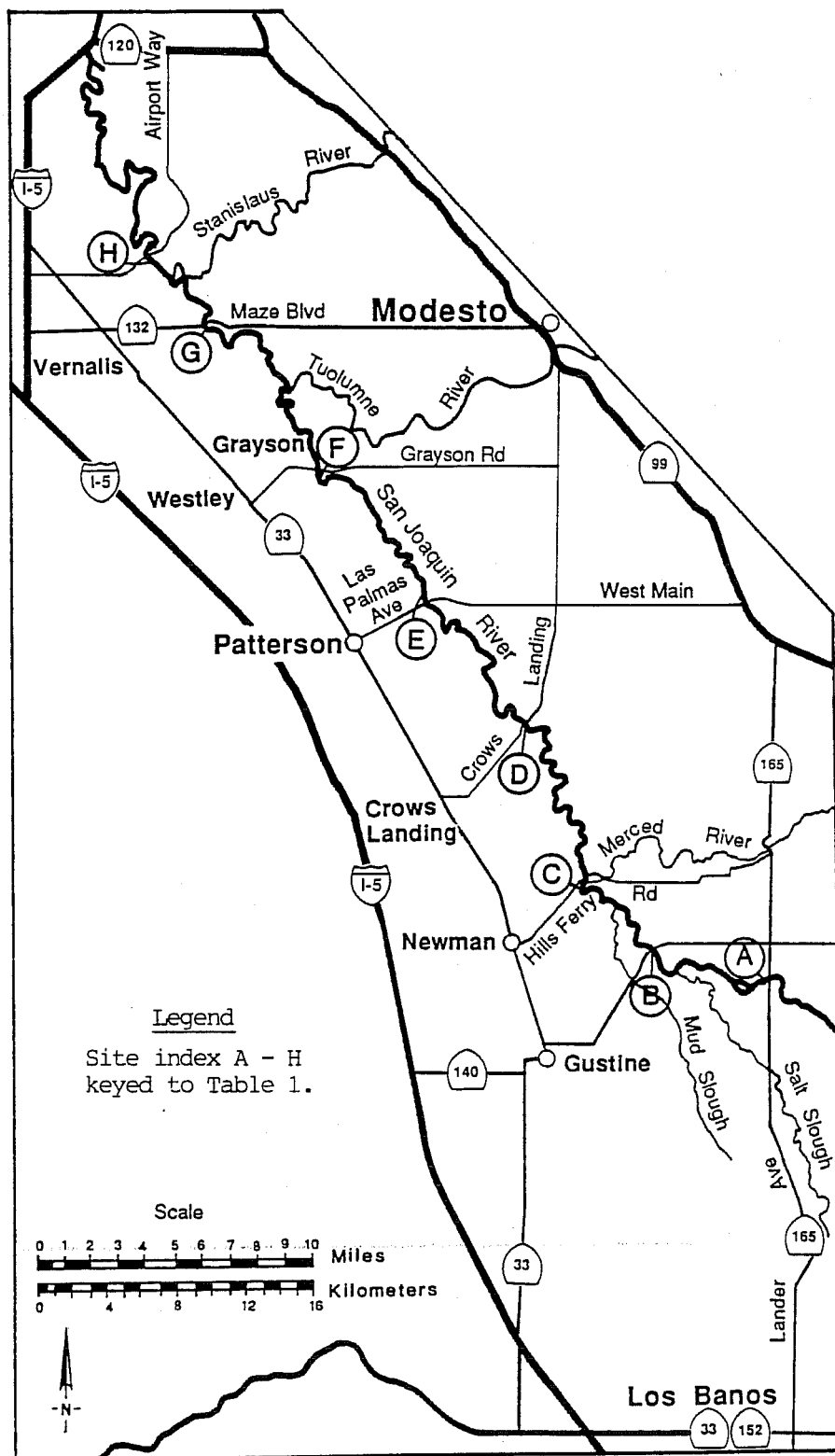


Fig. 2. Index Map

**Table 1. Tributaries and Drains to the San Joaquin River Between Lander Avenue and Airport Way**

River Mile	Description	Type*
132.9	<b>Lander Avenue (Site A)</b>	
129.7	Salt Slough	T,S
125.1	<b>Fremont Ford (Site B)</b>	
121.2	Mud Slough	T,S
119.6	Newman Wasteway	O,S
119.5	Newman Drainage District Collector Line A	T
119.1	Hills Ferry Road Drain	S
118.8	<b>Hills Ferry Road (Site C)</b>	
118.2	Merced River	N
117.5	Newman Drainage District Collector Line I	T
117.2	Azevedo Road Drain	S
113.4	Freitas Rd. Drain + south of Freitas Rd. Drain	S
112.0	Turlock Irrigation District Lateral 6	S,O
109.0	Orestimba Creek	N,S
107.2	<b>Crows Landing Road (Site D)</b>	
105.0	Spanish Grant, Marshall Rd., Moran Rd. Drain	S,T
103.5	Turlock Irrigation District Lateral 5	S
100.0	Ramona Lake Main Drain	S,T
098.6	Patterson Water District Main Drain	S,T
098.4	<b>Las Palmas Launching Facility (Site E)</b>	
097.6	Olive Avenue Drain	S
097.3	Lemon Avenue Drain	S
097.0	Eucalyptus Avenue Drain	S
095.2	Turlock Irrigation District Lateral 3	S
092.9	Del Puerto Creek	N,S
091.4	Houk Ranch Drain	S,T
090.3	Turlock Irrigation District Lateral 2	S
089.1	<b>Grayson Road (Site F)</b>	
087.0	Old San Joaquin River Channel	S
083.7	Tuolumne River	N
081.1	Merced Irrigation District Lateral 4	S
079.9	Hospital/Ingram Creeks	S,T
078.9	Center Road Drain	S
077.6	El Solyo Drain	S,T
077.4	Blewett Drain	S
077.3	<b>Maze Boulevard (Site G)</b>	
074.9	Stanislaus River	N
073.6	<b>Airport Way (Site H)</b>	

**\* LEGEND**

- S Surface Agricultural Drain
- T Subsurface Agricultural Drain
- N Natural Stream
- O Operational Spillage

## TEMPORAL VARIATIONS IN STREAMFLOW

A WY extends from 1 October of one year to 30 September of the following year. The average yearly flows of the San Joaquin River for the WYs 85-89 were given in James et al., (1988) and Westcot et al., (1989 and 1990). Streamflows in the 85, 87, 88, and 89 WYs were below the long-term average and in the 86 WY they were above average. The 90 WY, presented in this report, was also below average. WYs 87 through 89 were classified as critically dry years as described in James et al., (1988). The 90 WY is one of the few instances where a critically dry year has followed three previous critically dry years.

## METHODS

The Regional Board monitoring program for the San Joaquin River began in May 1985 and has continued through the 1990 WY. The frequency of sample collection varies, but generally grab samples were collected on a monthly basis. However, due to the extreme dry conditions encountered in WY 90, the sampling frequency was increased for five of the eight sites to biweekly or weekly. All samples were analyzed for total recoverable selenium, boron, chloride, sulfate, total hardness, and EC. Selected samples were also analyzed for molybdenum. Samples collected at the Hills Ferry Road site were analyzed for total recoverable copper, chromium, nickel, lead, zinc, selenium, molybdenum, and a full general mineral analysis on a monthly basis. Data recorded in the field included time, temperature, pH, and EC.

Selenium and trace element samples were preserved with ultra-pure nitric acid to lower the pH of the sample to two or less. Mineral samples were kept on ice until submitted to the laboratory for analysis. A quality control and quality assurance program was conducted. Spike and duplicate samples were utilized in the laboratory. In addition, blind replicate samples were collected at 10 percent of the sites and 50 percent of the blind replicates were spiked for laboratory quality assurance. Reported results fall within quality assurance tolerance guidelines.

## RESULTS

Concentrations of the measured constituents in WY 90 followed a consistent pattern along the San Joaquin River study area. The lowest concentrations generally occurred at the upstream study site at Lander Avenue while the highest concentrations occurred just downstream at Fremont Ford and Hills Ferry Road, which are located below the Salt Slough and Mud Slough (north) confluences, respectively (Figure 2). Downstream of the Hills Ferry Road site there was a progression of decreases in constituent concentrations as the Merced, Tuolumne, and Stanislaus Rivers each inflowed and diluted the San Joaquin River. These results are consistent with findings in WY 86 through WY 89 (James et al., 1988 and Westcot et al., 1989 and 1990).

Results of water quality analysis for minerals and trace elements are listed by site in Appendix A, Tables 1A-8A. The ranges and median concentrations at each site for selected mineral constituents and selenium and boron are shown in Table 2.

Table 2. Summary of Selected Mineral and Trace Element Water Quality Data from the San Joaquin River for the Critical Water Year (October 1989 - September 1990).

	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS * FERRY RD.	FREMONT FORD	LANDER AVENUE
<b>EC</b> (µmhos/cm)	Minimum	930	1250	1060	1180	1120	1180	440
	Median	1340	1430	1530	1710	2490	2400	1500
	Maximum	1640	1900	2160	2030	4120	3070	2940
	# Samples	(35)	(12)	(12)	(49)	(48)	(49)	(48)
<b>Cl</b> (mg/L)	Minimum	130	170	150	140	170	160	49
	Median	190	200	225	230	380	320	200
	Maximum	235	285	300	320	530	510	500
	# Samples	(19)	(12)	(12)	(32)	(42)	(31)	(30)
<b>SO4</b> (mg/L)	Minimum	130	170	160	170	180	220	35
	Median	230	250	290	280	520	480	83
	Maximum	290	360	430	430	770	790	280
	# Samples	(19)	(12)	(12)	(32)	(42)	(31)	(30)
<b>HDNS</b> (mg/L)	Minimum	210	260	230	230	270	255	100
	Median	290	340	330	330	540	490	180
	Maximum	370	510	470	470	720	780	400
	# Samples	(19)	(12)	(12)	(32)	(41)	(31)	(30)
<b>B</b> (mg/L)	Minimum	0.55	0.66	0.67	0.67	0.88	0.82	0.09
	Median	0.79	0.91	1.1	1.2	2.1	2.0	0.33
	Maximum	1.2	1.2	1.5	1.7	3.2	3.3	0.69
	# Samples	(35)	(12)	(12)	(49)	(48)	(49)	(49)
<b>Se</b> (µg/L)	Minimum	1.7	2.9	1.7	1.6	2.7	4.4	<0.2
	Median	4.0	5.0	4.6	7.2	11	14	0.4
	Maximum	9.8	10	10	13	26	33	1.7
	# Samples	(35)	(12)	(12)	(49)	(49)	(49)	(49)
<b>Mo</b> (µg/L)	Minimum	1			2	3	4	3
	Median	4			5	8	8	20
	Maximum	6			8	18	14	59
	# Samples	(20)			(48)	(48)	(26)	(48)

\* Additional data ranges for Ca, Mg, Na, K, Tot. Alk., TDS, Cu, Cr, Pb, Ni, and Zn for the Hills Ferry Road site are given in Appendix A, Table 3A.



The ranges and median values at each monitoring site are graphically represented for EC, chloride, sulfate, boron, selenium and molybdenum in Appendix B, Figures 1B through 6B, respectively. These graphs show the general trend in the concentrations of these selected minerals and trace elements along the entire study area. For all constituents except molybdenum, the lowest concentrations occurred at Lander Avenue, the upstream study end point, while the highest concentrations occurred at the next two downstream sites, Fremont Ford and Hills Ferry Road. The Lander Avenue site represents upstream background concentrations as no subsurface drainage water enters the river prior to this site. During dry and critically dry years, flow at this site is greatly reduced. The sites at Fremont Ford and Hills Ferry Road contain significant concentrations of subsurface drainage water which enters upstream of these sites, but below Lander Avenue. Downstream of the Hills Ferry Road site, the Merced River inflows and dilutes the river, thus concentrations at the next three sites downstream are lower than at Hills Ferry Road. These three sites, Crows Landing, Las Palmas Avenue, and Grayson Road, are located between the Merced and Tuolumne Rivers and their concentrations do not change significantly between these sites. The concentrations were further reduced in the river downstream of the Tuolumne and Stanislaus River inflows as measured at Maze Boulevard and Airport Way, respectively. The trend of decreasing concentrations as you move downstream are shown for boron, EC and selenium in Figures 3, 4 and 5, respectively. This downstream trend was also recorded by Gilliom (1986) and Clifton and Gilliom (1988). During an above normal water year, such as was found in WY 86, the quality at Lander Avenue (upstream site) is essentially the same as that found at the downstream site at Airport Way (Vernalis) due to dilution from eastside streams. In dry or critically dry water years, the upstream site often shows consistently poorer quality water than the downstream site. This poorer quality water at the upstream site is likely due to low flow conditions in the River at that point.

The Hills Ferry Road site had the highest median EC (2490  $\mu$ mhos/cm), boron (2.1 mg/L) and sulfate (520 mg/L). These values are generally only slightly higher than those at Fremont Ford. This pattern is consistent with findings through WY 88 as both Salt Slough and Mud Slough (north) were used to transport subsurface drainage water to the river. In WY 89, however, it was noted that the majority of the drainage water was discharged through Salt Slough with the result that the highest median concentrations in the river were found immediately downstream at Fremont Ford (Table 1)(Westcot et al., 1990). Even though the highest median for EC, boron, and sulfate were found at the Hills Ferry Road site, this site did not show the highest median concentration for selenium. The highest median selenium concentration was found at the Fremont Ford site, indicating that Salt Slough continued to be the main source of subsurface drainage water being discharged to the river. Selenium concentrations are the best illustration of the drainage inflow as greater than 95 percent of the selenium in the river comes from the discharge of subsurface agricultural drainage water (SWRCB, 1987).

The increased concentration downstream of Fremont Ford could be related to other discharges entering through Mud Slough (north) or to the low flow conditions found in WY 90, which may have resulted in poor quality ground water seepage into the river being a higher percentage of the total flow at Hills Ferry Road. The latter may be a strong possibility as the highest median chloride concentration was also seen at the Hills Ferry Road site. Data, however, was inadequate to make a complete assessment.

# Water Year 1990

Hills Ferry, Crows Landing, Airport Way

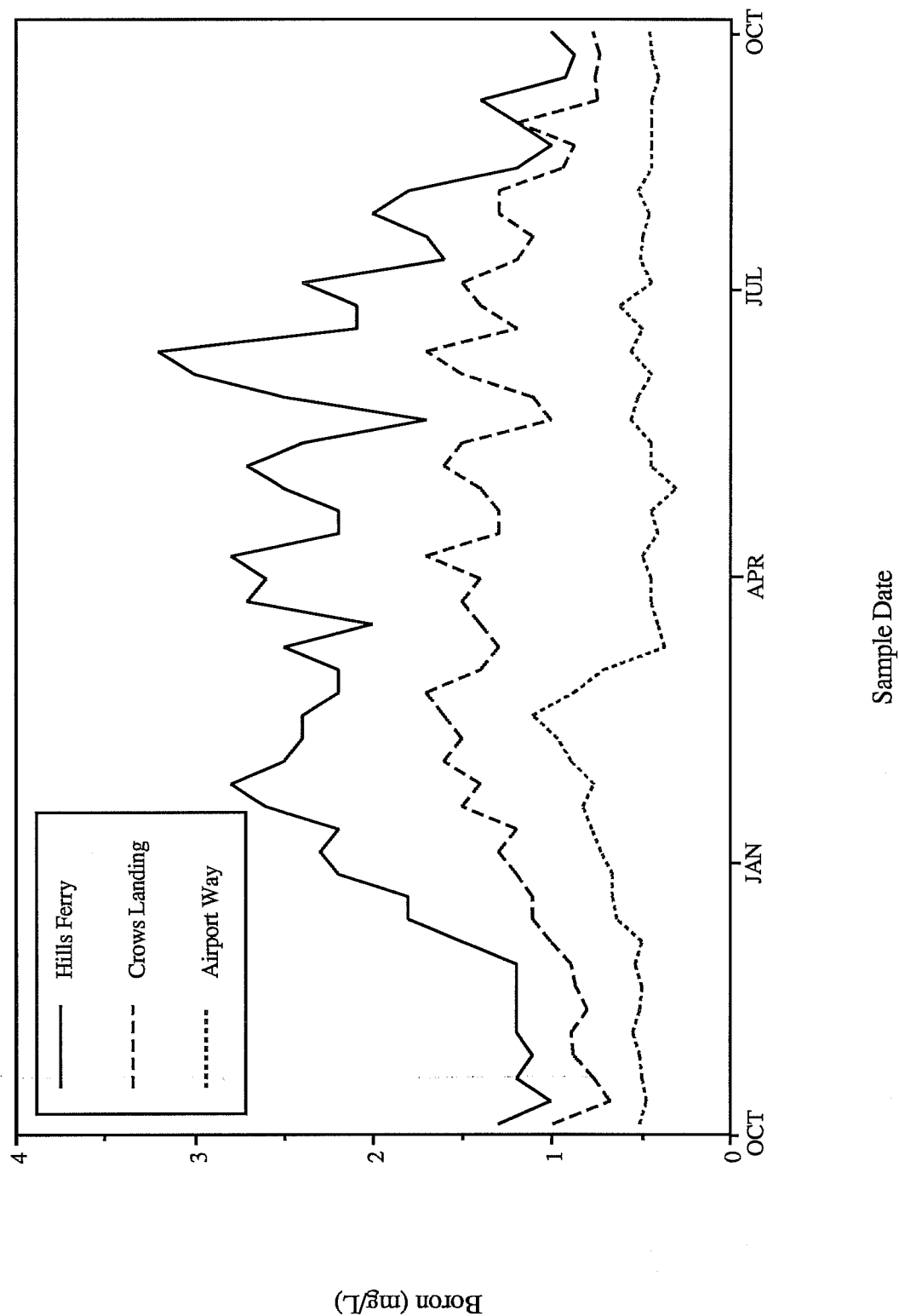


Figure 3. Boron Concentrations at Three Monitoring Sites Along the Lower San Joaquin River in Water Year 1990 (October 1989 through September 1990).

## Water Year 1990

Hills Ferry, Crows Landing, Airport Way

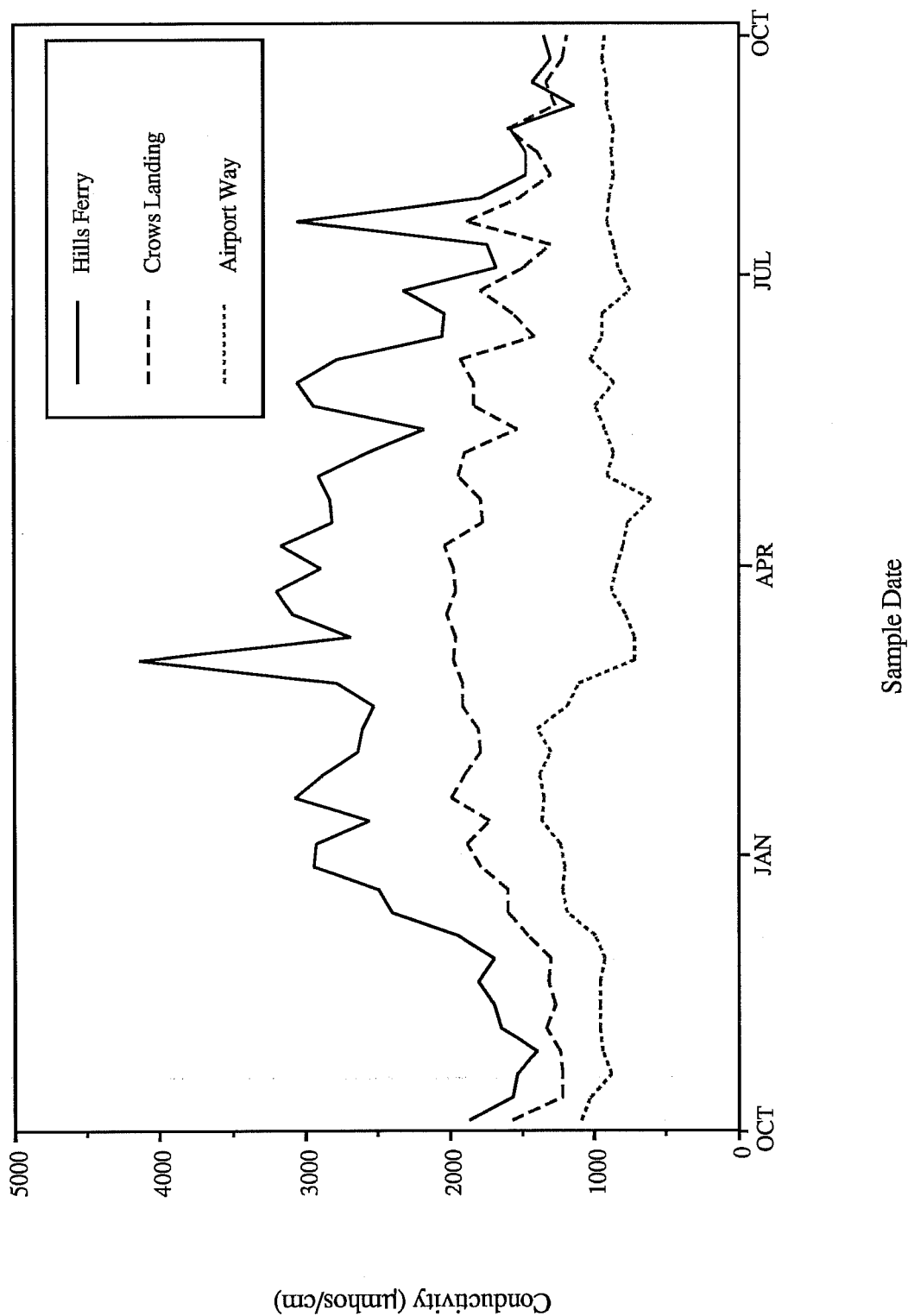


Figure 4. Electrical Conductivity at Three Monitoring Sites Along the Lower San Joaquin River in Water Year 1990 (October 1989 through September 1990).

## Water Year 1990

Hills Ferry, Crows Landing, Airport Way

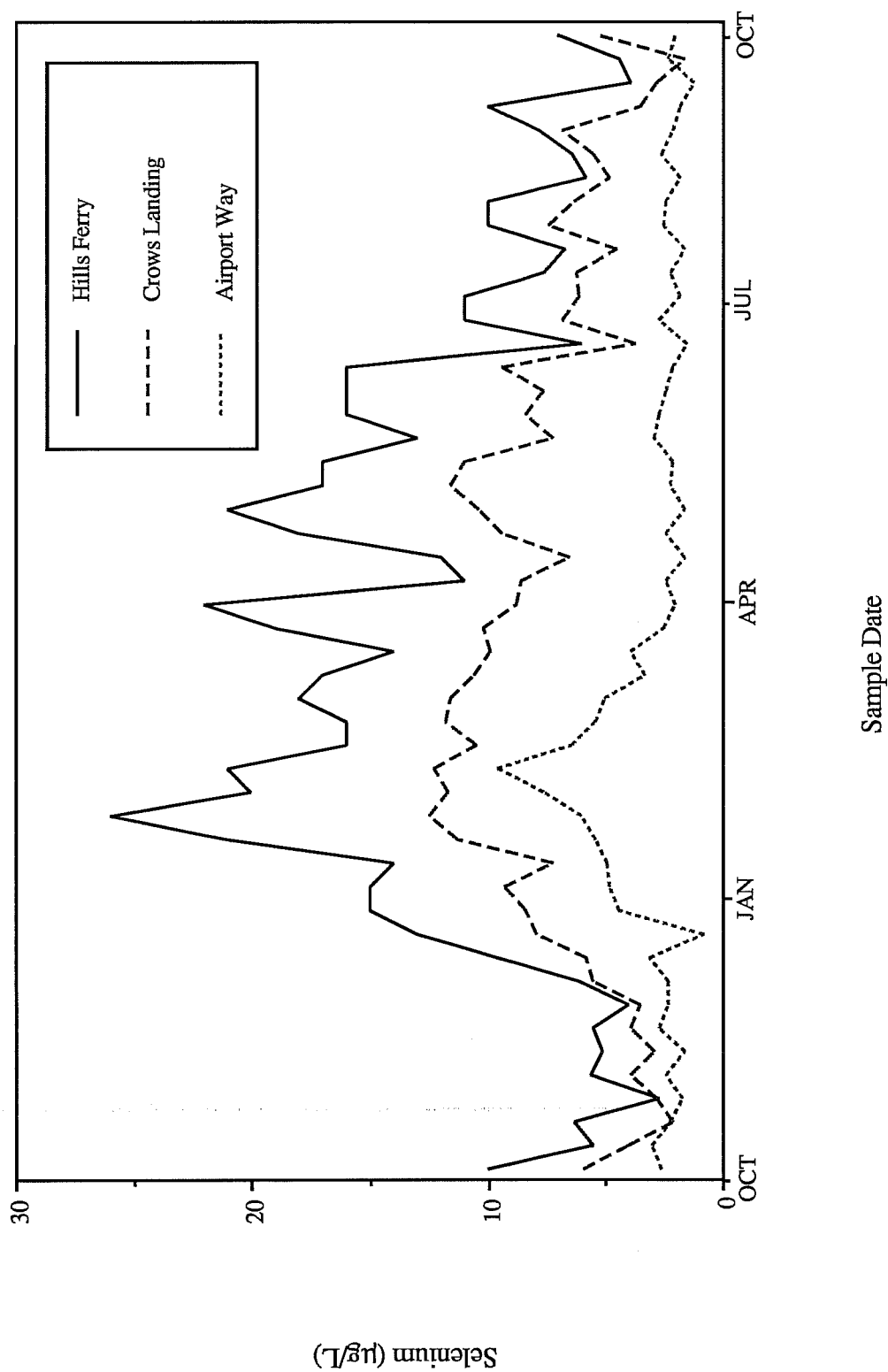


Figure 5. Selenium Concentrations at Three Monitoring Sites Along the Lower San Joaquin River in Water Year 1990 (October 1989 through September 1990).

Following a trend noticed in the 86-89 WY data (James et al., 1988 and Westcot et al., 1989 and 1990), EC and boron values are generally highest during the drier water years (including WY 90). EC and boron values for the critical 87 through 90 WYs were routinely higher than they were during the wet 86 WY. As shown by James et al., (1988) at the Hills Ferry Road site during the wet 86 WY, the median EC value was 1100  $\mu\text{mhos/cm}$  (Table 3). The median EC value increased in the critical 87 WY to 1720  $\mu\text{mhos/cm}$ . During the fourth consecutive critically dry 90 WY, EC values were even higher, ranging from 1120 to 4120  $\mu\text{mhos/cm}$  with a median of 2490  $\mu\text{mhos/cm}$ . Boron values followed the same trend. During the wet 86 WY, at Hills Ferry the median boron value was 0.91 mg/L (Table 3). In the critical 87 WY and 88 WY, the median values were 1.6 mg/L and 1.7 mg/L, respectively. The median boron concentration found in WY 89 and 90 were 1.7 mg/l and 2.2 mg/l, respectively. This trend was observed at all of the monitoring sites.

The EC and boron values along the river do impose a slight to moderate degree of restriction on the use of river water for irrigation. Extreme EC and boron values at Fremont Ford and Hills Ferry Road have been high enough to impose severe restrictions for irrigation, but these extreme values occurred during the nonirrigation season.

Selenium concentrations at the Hills Ferry site followed the same general trend observed for EC and boron with the highest concentrations occurring during the critically dry 87 through 90 WYs with median values for WY 86, WY 87, WY 88, and WY 89 being 4.0  $\mu\text{g/L}$ , 11  $\mu\text{g/L}$ , 10  $\mu\text{g/L}$ , and 9.8  $\mu\text{g/L}$ , respectively (Table 4). The median value for WY 90 is 11  $\mu\text{g/L}$ . Similar trends were observed at downstream sites. Figures 6 and 7 show the selenium concentrations with time for the selected water years for the Crows Landing site (Index D) and Maze Road site (Index G). Figures 8 and 9 show the boron concentrations for the same water years and sites. As can be seen in all these figures, during dry and critically dry years the time of year patterns remain the same. One possible explanation for this relationship is that during times of low streamflow, as found in critically dry water years, agricultural drainage water makes up a larger proportion of the San Joaquin River flow and consequently, constituents associated with this drainage water become elevated in the River.

The upstream Lander Avenue site is considered the background water quality site for this study. However, the highest median values for molybdenum (20  $\mu\text{g/L}$ ) occurred at the Lander Avenue site which is upstream of the discharge of tile drainage (Table 4). These levels are not caused by subsurface drainage water, as shown by the continued low concentrations of sulfate, boron, and selenium (Figures 3B, 4B, and 5B in Appendix B), all of which are chief components of the drainage water. Prior to WY 87, which was the first critically dry year (James et al., 1988), median quality at the Lander Avenue site was comparable to that at Vernalis. However, as seen in WY 88 and WY 89 (Westcot et al., 1989 and 1990), and in the critically dry WY 90, conditions have produced a change including higher median EC levels and molybdenum concentrations and lower median selenium and boron concentrations at Lander Avenue as compared to the Vernalis site. In WY 90, greater than 50 percent of the samples collected exceeded the monthly mean for molybdenum (19  $\mu\text{g/l}$ ) established in the Basin Plan for the San Joaquin River. Five of the samples exceeded the maximum (50  $\mu\text{g/l}$ ) concentration established in the Plan (Table 5). Because of the very dry conditions in WY 90, flow at the Lander Avenue site was low. James et al., (1989) stated that flow

Table 3. Ranges of Electrical Conductivity and Boron Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88 taken from Westcott et al., 1989).

WY 1985 DRY	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC (µmhos/cm)	Minimum 480 Median 540 Maximum 680 # Samples (6)	620 860 900 (6)	690 1000 1050 (5)	640 1050 1200 (6)	630 995 1200 (6)	730 1325 2200 (6)	640 1150 1900 (6)	192 700 1300 (5)
B (mg/L)	Minimum 0.20 Median 0.27 Maximum 0.45 # Samples (6)	0.25 0.43 0.60 (6)	0.38 0.48 0.78 (5)	0.26 0.62 0.86 (6)	0.27 0.64 0.85 (6)	0.45 1.10 1.60 (6)	0.33 0.93 1.20 (6)	<0.01 0.10 0.36 (5)
WY 1986 WET	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC (µmhos/cm)	Minimum 180 Median 540 Maximum 980 # Samples (18)	200 700 1100 (17)	280 960 1700 (15)	240 870 1800 (18)	270 815 1700 (18)	410 1100 2600 (18)	94 905 2300 (18)	73 400 930 (18)
B (mg/L)	Minimum 0.10 Median 0.22 Maximum 0.7 # Samples (17)	0.13 0.39 0.70 (17)	0.17 0.57 1.2 (15)	0.11 0.56 1.7 (18)	0.14 0.59 1.2 (18)	0.29 0.91 2.2 (18)	0.09 0.65 1.8 (18)	<0.01 0.10 0.61 (18)
WY 1987 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC (µmhos/cm)	Minimum 340 Median 804 Maximum 930 # Samples (13)	490 1100 1420 (9)	1200 1300 1890 (9)	1200 1360 1960 (9)	1200 1320 1990 (13)	1600 1720 2600 (10)	1330 1730 2880 (12)	650 1200 1650 (13)
B (mg/L)	Minimum 0.18 Median 0.43 Maximum 0.62 # Samples (15)	0.30 0.64 1.1 (11)	0.59 0.88 1.6 (11)	0.70 0.95 1.8 (11)	0.67 0.94 1.9 (15)	0.53 1.6 3 (13)	0.81 1.6 3.2 (14)	0.10 0.21 0.35 (15)
WY 1988 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC (µmhos/cm)	Minimum 650 Median 900 Maximum 1450 # Samples (43)	1010 1400 1600 (13)	1300 1580 1950 (12)	750 1600 2150 (14)	1180 1600 2150 (43)	1380 1990 3100 (41)	1260 1950 2950 (42)	320 1550 2100 (40)
B (mg/L)	Minimum 0.28 Median 0.50 Maximum 0.95 # Samples (43)	0.50 0.90 1.1 (13)	0.66 1.0 1.5 (12)	0.48 1.2 3 (14)	0.46 1.2 2 (43)	0.57 1.7 3.1 (41)	0.41 1.8 2.8 (42)	0.03 0.30 0.47 (40)

Table 3 Continued. Ranges of Electrical Conductivity and Boron Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88 taken from Westcott et al., 1989).

WY 1989 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC (µmhos/cm)	Minimum 720 Median 980 Maximum 1510 # Samples (46)	880 1290 1740 (14)	1160 1480 2100 (13)	1220 1490 2220 (13)	1000 1520 2210 (47)	1360 1930 3350 (46)	1300 2010 3300 (47)	380 1500 1990 (47)
B (mg/L)	Minimum 0.37 Median 0.54 Maximum 1.0 # Samples (45)	0.6 0.8 1.2 (14)	0.64 0.9 1.6 (13)	0.76 1.0 1.8 (13)	0.68 1.2 1.9 (46)	0.69 1.7 3.0 (46)	0.67 1.8 3.3 (46)	0.06 0.32 0.54 (46)
WY 1990 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC (µmhos/cm)	Minimum 600 Median 920 Maximum 1380 # Samples (49)	930 1340 1640 (35)	1250 1430 1900 (12)	1060 1530 2160 (12)	1180 1710 2030 (49)	1120 2490 4120 (46)	1180 2400 3070 (49)	440 1500 2940 (48)
B (mg/L)	Minimum 0.31 Median 0.50 Maximum 1.1 # Samples (49)	0.55 0.79 1.2 (35)	0.66 0.91 1.2 (12)	0.67 1.1 1.5 (12)	0.67 1.2 1.7 (49)	0.88 2.1 3.2 (48)	0.82 2.0 3.3 (49)	0.09 0.33 0.69 (49)

Table 4. Ranges of Selenium and Molybdenum Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88 taken from Westcott et al., 1989.

WY 1985 DRY	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Minimum	1	1	1	<1	1	1	<1	<1
Median	1	2	2	3	3	4	3.5	<1
Maximum	2	3	3	4	4	8	7	1
# Samples	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(5)
WY 1986 WET	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Minimum	0.6 (<1)	0.8 (<1)	0.9 (<1)	<1	<1	<1	<1	0.2 (<1)
Median	1	1.5	2.2	2	2	4	1.7	0.3
Maximum	4	2.4	4	5	4	8	9	5
# Samples	(19)	(19)	(16)	(18)	(19)	(19)	(19)	(19)
Minimum	0.6 (<1)	<1	<1	<1	<1	2.6 (<5)	2.9 (<5)	<1
Median	1.6 (<5)	<5	<5	<5	<5	5.1	<5	<5
Maximum	(16)	8	13	12	14	14	17	5
# Samples	(16)	(15)	(12)	(17)	(14)	(16)	(16)	(15)
WY 1987 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Minimum	0.9	1.4	3.4	3.4	3.6	6.6	4.3	0.4
Median	2.3	3.3	4.6	4.8	5.6	11	10	0.7
Maximum	3.2	5.8	9.3	10	12	21	26	1.8
# Samples	(15)	(11)	(11)	(11)	(15)	(15)	(14)	(15)
Minimum	1 (<5)	<5	<5	<5	4 (<5)	<5	<5	4 (<5)
Median	2 (<5)	<5	<5	<5	4	7	5	7
Maximum	2 (<5)	<5	<5	6	5	12	9	14
# Samples	(11)	(3)	(3)	(3)	(10)	(11)	(3)	(10)
WY 1988 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Minimum	0.8	1.9	2.4	2.0	0.8	1.0	1.3	0.2
Median	2.7	5.1	5.8	6.2	7.4	10	12	0.7
Maximum	6.5	6.5	8.5	9.1	12	20	23	1.4
# Samples	(41)	(13)	(12)	(14)	(42)	(41)	(40)	(38)
Minimum	2				3	4		3
Median	3				5	6		15
Maximum	4				7	11		22
# Samples	(6)				(35)	(30)		(35)



Table 4 Continued. Ranges of Selenium and Molybdenum Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88 taken from Westcot et al., 1989.

WY 1989 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se (µg/L)	Minimum 2.9 Median 6.8 Maximum # Samples (46)	3.2 4.4 8.0 (14)	3.5 5.8 12 (13)	3.0 6.0 14 (13)	3.4 6.9 17 (47)	2.8 9.8 23 (46)	3.4 12 32 (47)	0.3 0.5 1.3 (46)
Mo (µg/L)	Minimum 2 Median 5 Maximum # Samples (44)	2 4 6 (4)			2 4 7 (46)	3 6 11 (46)		1 16 30 (47)
WY 1990 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se (µg/L)	Minimum 0.8 Median 2.4 Maximum 9.6 # Samples (49)	1.7 4.0 9.8 (35)	2.9 5.0 10 (12)	1.7 4.6 10 (12)	1.6 7.2 13 (49)	2.7 11 26 (49)	4.4 14 33 (49)	<0.2 0.4 1.7 (49)
Mo (µg/L)	Minimum 1 Median 2 Maximum 5 # Samples (46)	1 4 6 (20)			2 5 8 (48)	3 8 18 (48)	4 8 14 (26)	3 20 59 (48)

# San Joaquin River at Crows Landing Road

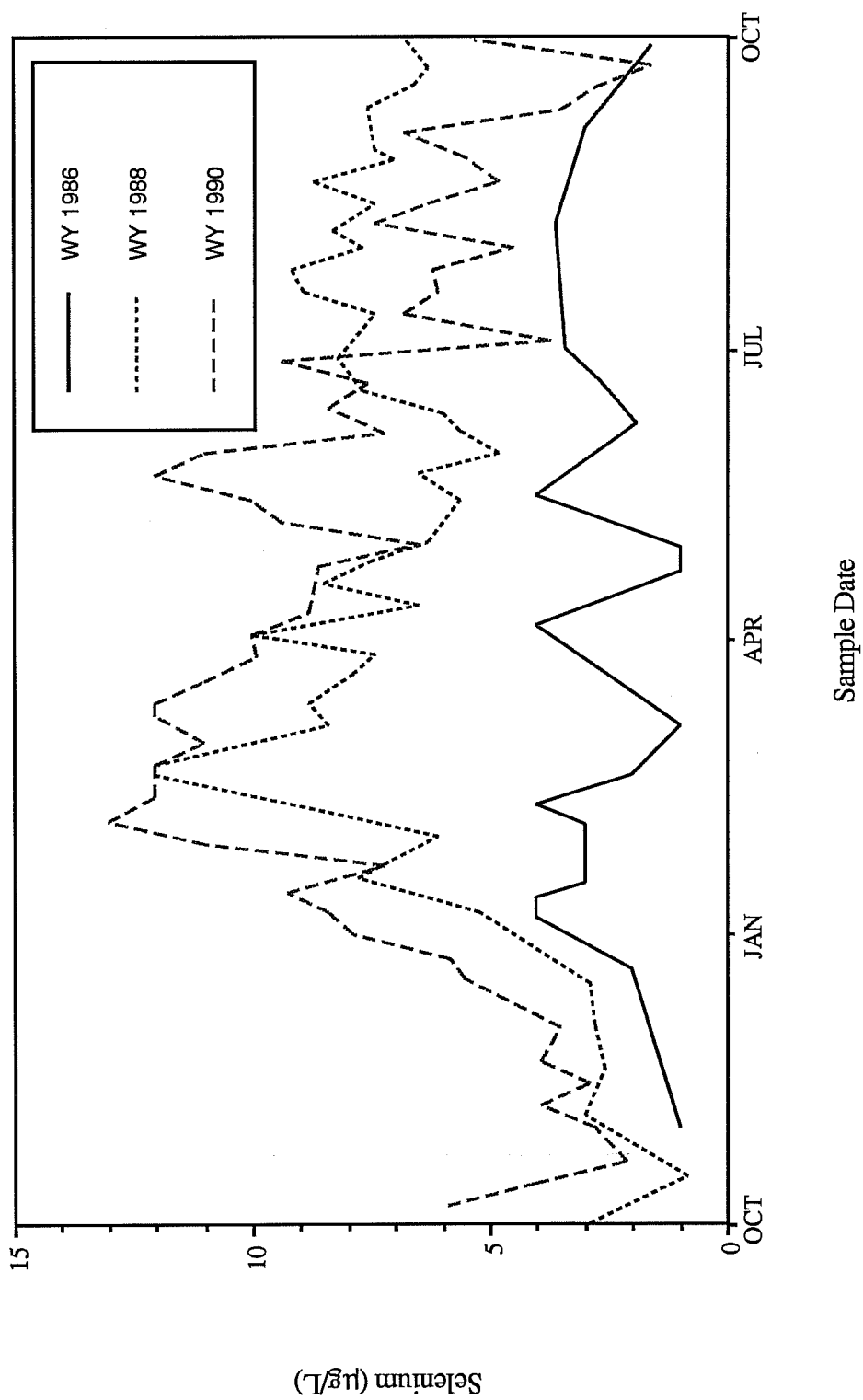


Figure 6. Selenium Concentrations at Crows Landing Road Along the Lower San Joaquin River for Water Years 1986, 1988 and 1990.

# San Joaquin River at Maze Blvd.

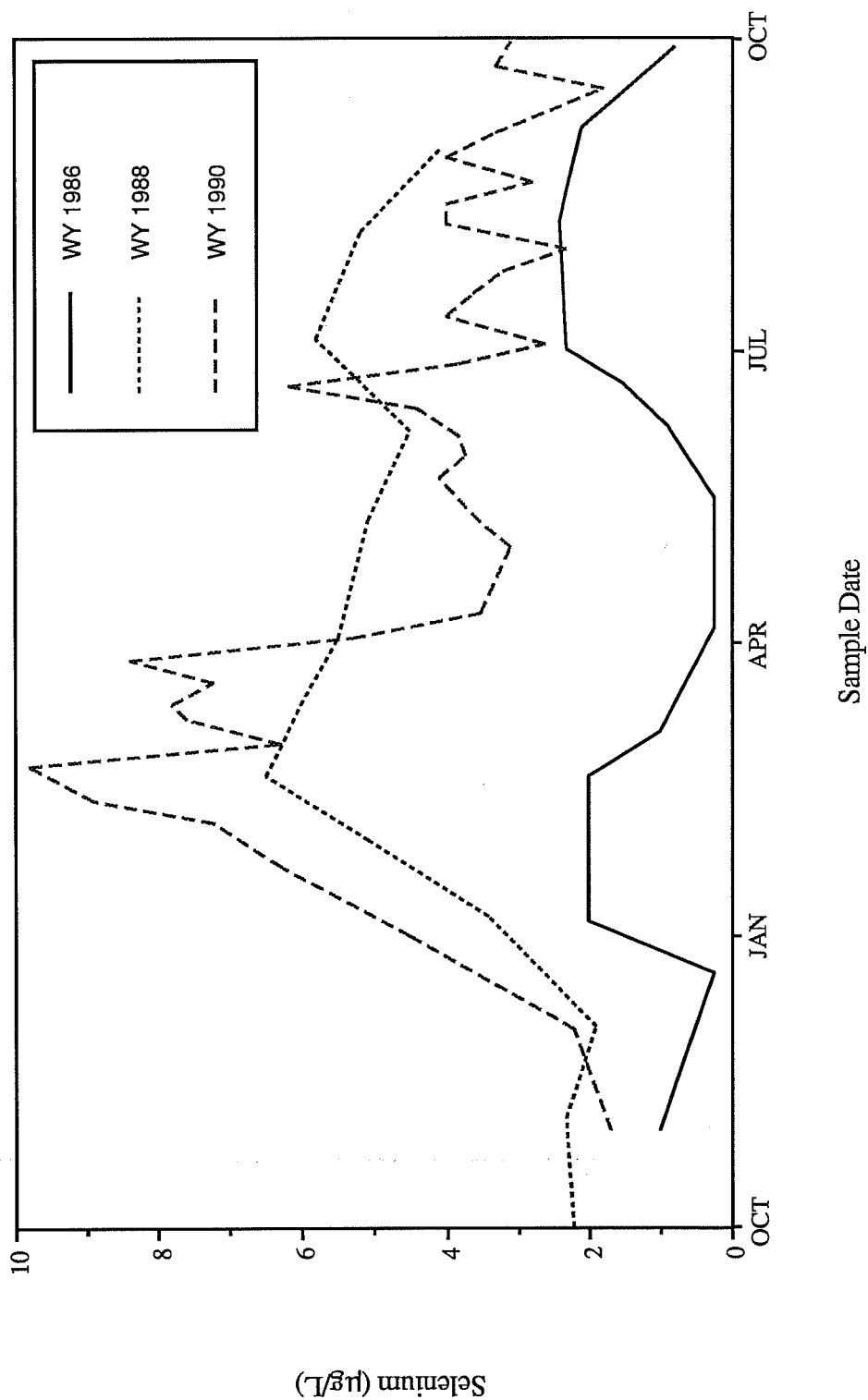


Figure 7. Selenium Concentrations at Maze Blvd. Bridge (Highway 132) Along the Lower San Joaquin River for Water Years 1986, 1988 and 1990.

# San Joaquin River at Crows Landing Road

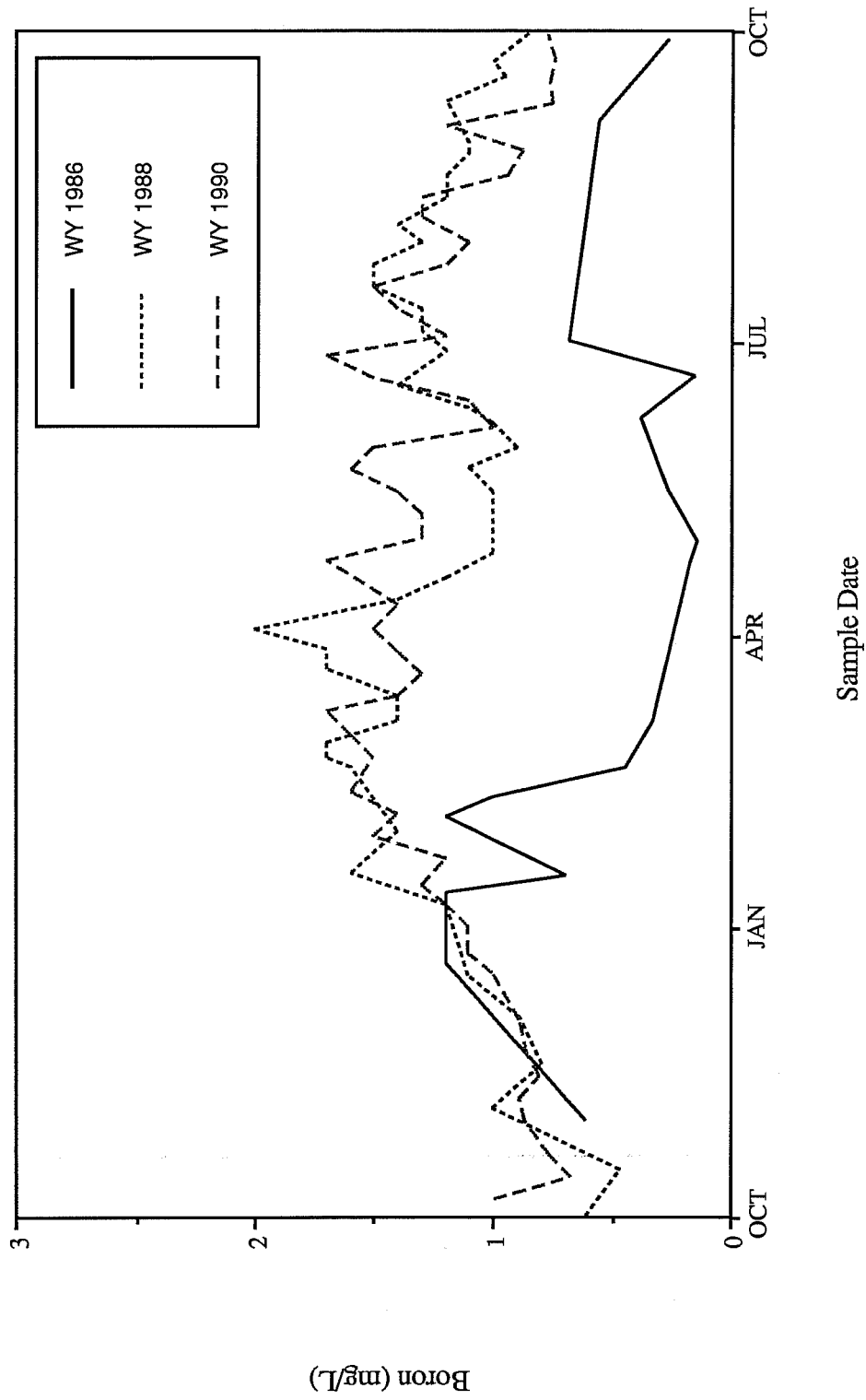


Figure 8. Boron Concentrations at Crows Landing Road Along the Lower San Joaquin River for Water Years 1986, 1988 and 1990.

# San Joaquin River at Maze Blvd.

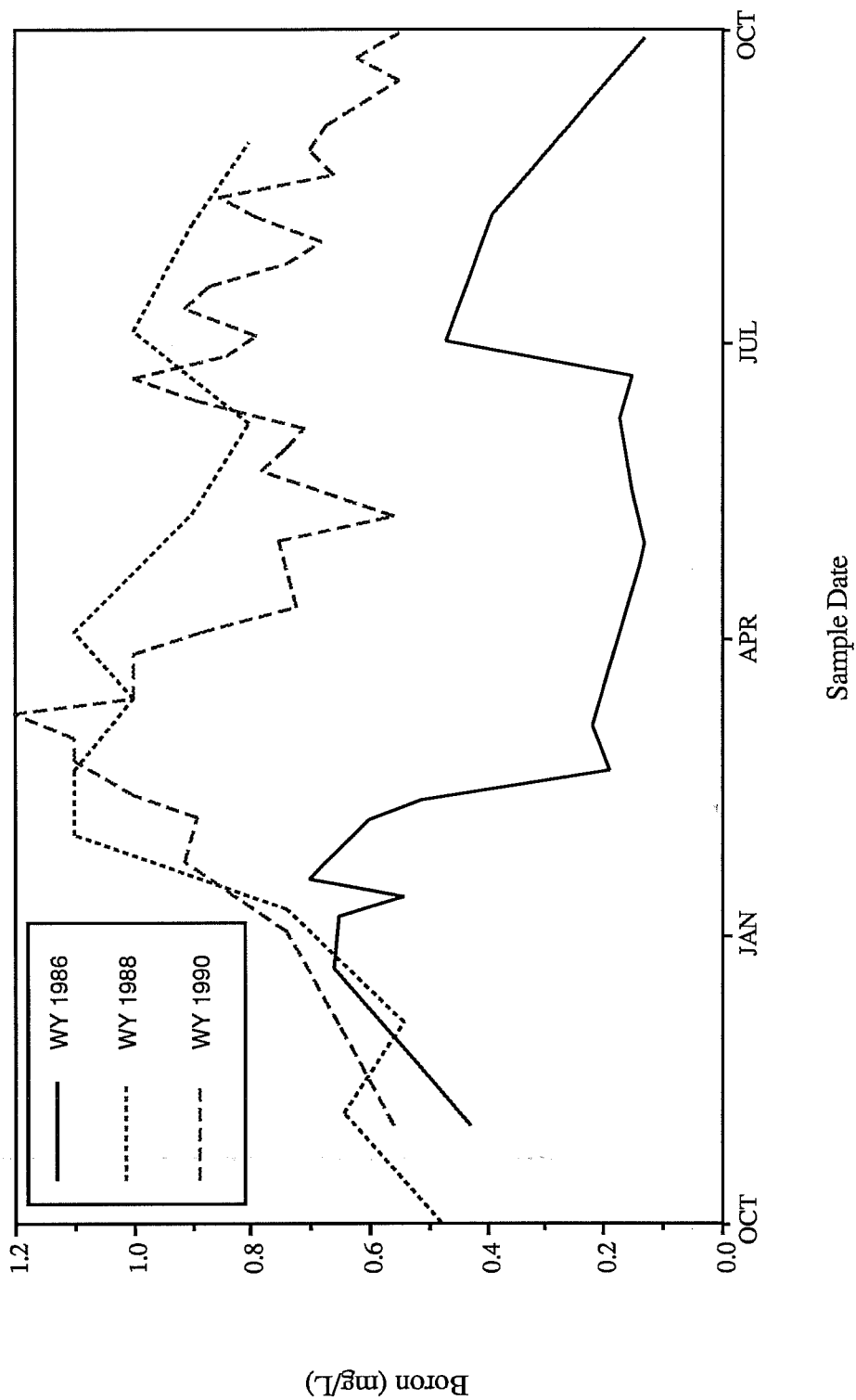


Figure 9. Boron Concentrations at Maze Blvd. Bridge (Highway 132) Along the Lower San Joaquin River for Water Years 1986, 1988 and 1990.

**Table 5 Water Quality Objectives as Adopted by the Central Valley Regional Board for the San Joaquin Basin (5C)**

<u>Constituent</u>	<u>Water Quality Objectives</u>	<u>Compliance Date</u>
<b>San Joaquin River, mouth of the Merced River to Vernalis (Delta Inflow)</b>		
Selenium	5 µg/l monthly mean	12 µg/l maximum
	8 µg/l monthly mean (critical year only)	1991
Molybdenum	10 µg/l monthly mean	15 µg/l maximum
Boron	0.8 mg/l monthly mean (15 March - 15 Sept)	2.0 mg/l maximum
	1.0 mg/l monthly mean (16 Sept - 14 March)	2.6 mg/l maximum
	1.3 mg/l monthly mean (critical year only)	1991
<b>Salt Slough, Mud Slough (north), San Joaquin River, Sack Dam to mouth of the Merced River*</b>		
Selenium	10 µg/l monthly mean	26 µg/l maximum
Molybdenum	19 µg/l monthly mean	50 µg/l maximum
Boron	2.0 mg/l monthly mean (15 March - 15 Sept)	5.8 mg/l maximum

at this point in the river is often made up of only ground water seepage into the river. The high median molybdenum concentration at this site and the very low median selenium concentration shown at the same time suggests that ground water seepage from the basin trough areas may be occurring (Deverel et al., 1984 and Chilcott et al., 1988).

James et al. (1988) also showed seasonal variations within a given water year. In their analysis, each water year was roughly divided into the irrigation and nonirrigation seasons. The irrigation season was defined to extend from April to September and the nonirrigation season from October to March. Comparing these two seasons showed the nonirrigation season generally had the higher EC, boron

and selenium concentrations at each site along the river regardless of water year type. During the irrigation season surface irrigation return flows make up a large proportion of the San Joaquin River flow and these return flows have a diluting effect on the water quality of the river. The Crows Landing site shows a steady increase in concentration each year after October, the nonirrigation season, regardless of water year type. Subsurface tile drainage lines are continuing to discharge at this time while surface irrigation return flows have ceased discharging to the river and no longer provide a diluting effect on the water quality. Boron, EC and selenium concentrations at those locations along the river course during the irrigation and nonirrigation seasons are shown in Figures 3-5 for WY 90. Figures 6 and 7 show that the peak and low selenium concentration periods occurred at approximately the same time each year during the two critically dry water years (WY 88 and WY 90) and the absence of the well defined peaks during wet WY 86.

The existing water quality guidelines and criteria for the protection of beneficial uses are shown in Table 6. Current EPA guidelines and criteria are based on acid-soluble analyses. The more conservative total recoverable analyses values utilized in this monitoring program may not be directly comparable to the acid-soluble based criteria, but reliable methods for acid-soluble analyses have not been developed to date. Total recoverable data currently provides the closest comparison of water quality analyses to these protective guidelines and should provide a worst case example.

The 90 WY median selenium values from Fremont Ford (14  $\mu\text{g/L}$ ) to Grayson Road (5.0  $\mu\text{g/L}$ ) equaled or exceeded the EPA ambient water quality criteria of 5  $\mu\text{g/L}$  for the protection of freshwater aquatic life. Selenium concentrations at sites upstream of Hills Ferry Road routinely exceed the primary drinking water standard of 10  $\mu\text{g/L}$ . A program to reduce drainage flow and river concentrations is being implemented and is expected to lower these concentrations. However, as shown in Table 5 different water quality objectives apply in critically dry years when little or no dilution flows will be available in the river.

The total recoverable trace element concentrations for copper, chromium, nickel, lead and zinc were only determined at the Hills Ferry Road site (Table 3A, Appendix A). Extreme total recoverable chromium values at the Hills Ferry Road site have exceeded the EPA ambient water quality criterion of 11  $\mu\text{g/L}$  hexavalent chromium for the protection of fresh water aquatic life, but the median values are well below this level. Acid-soluble hexavalent chromium levels were not evaluated in this study, but are expected to be lower than total recoverable chromium. Dissolved concentrations, however, were greatly different from the total recoverable levels. As shown in Table 7, dissolved chromium levels were <1  $\mu\text{g/L}$  throughout the period of sampling. This difference between dissolved and total recoverable concentrations illustrates the need to continue to develop reliable dissolved data when total recoverable concentrations show elevated levels. The dissolved chromium values may better represent hexavalent chromium concentrations in the water column since hexavalent chromium would tend to be soluble under normal stream conditions.

Median and maximum total recoverable nickel and zinc values were all below the EPA guideline for the protection of freshwater aquatic life. The maximum value for total recoverable copper did not exceed the EPA guideline of 7.5  $\mu\text{g/L}$  for a maximum nor did the median exceed the EPA guideline of 5.4  $\mu\text{g/L}$  for protection

**Table 6. Water Quality Guidelines and Criteria for the Protection of Beneficial Uses**

Constituent	Domestic/Municipal Drinking Water		Ambient water quality criteria to protect freshwater aquatic life	Irrigation Degree of Restriction on Use		Stock Water
	Primary	Secondary Other (health)		None	Slight to Moderate	
	- µg/l *	- µg/l *	4 day average - µg/l *	- mg/l *	- mg/l *	- mg/l *
Arsenic	50		190	0.1		0.2
Boron			360	< 0.7	0.7 - 3.0	5
Cadmium	10		0.55 <sup>a</sup>	0.01		0.05
Chromium (VI)	50†		11	0.1		1
Copper		1000	5.4 <sup>a</sup>	0.2		0.5
Iron		300		5		
Lead (inorganic)	50		0.99 <sup>a</sup>	5		0.1
Mercury	2		0.012			0.01
Molybdenum		70		0.01		
Nickel			73 <sup>a</sup>	0.02		
Selenium	10		20	0.02		0.05
Silver	50		13			
Zinc		5000	49 <sup>a</sup>	2		24
TDS (mg/l)		500 ††		< 450	450 - 2000	> 2000
EC				< 700	700 - 3000	> 3000
						< 5000

\* Acid soluble metals

† Total recoverable chromium

†† Recommended value (Recommended level = 500 mg/l; Maximum = 1000 mg/L; Short term level = 1500 mg/l) (References: Ayers and Westcot, 1985; EPA, 1987; EPA, 1985a; EPA, 1985b; EPA, 1980; EPA, 1979; Marshack, 1987; and SWRCB, 1987.)

<sup>a</sup> Criteria increase with increasing hardness of the water. These values are based on a hardness of 40 mg/l.



Table 7. Dissolved Trace Element and Hardness Water Quality Data for the San Joaquin River South of Hills Ferry Road (site index C) (STC512) for Water Year 1990.

Sample Date	Cr	Cu	Pb μg/L	Ni	Zn	Hardness mg/L
10/13/89	<1	2	<5	<5	2	290
10/30/89	<1	2	<5	<5	2	270
11/13/89	<1	1	<5	<5	—	—
11/20/89	<1	<1	<5	<5	<1	320
11/30/89	2	6	<5	5	<1	300
12/8/89	<1	<1	<5	<5	<1	400
12/15/89	<1	1	<5	<5	<1	390
12/21/89	<1	1	<5	<5	<1	450
12/29/89	<1	<1	<5	<5	<1	500
1/5/90	<1	<1	<5	<5	2	650
1/11/90	<1	<1	<5	<5	<1	670
1/19/90	<2	<1	<5	<5	<1	540
2/9/90	<1	<1	<5	<5	<1	580
2/26/90	<1	<1	<5	<5	<1	570
3/5/90	<1	<1	<5	<5	<1	540
3/9/90	<1	<1	<5	<5	<1	610
3/16/90	<1	<1	<5	<5	<1	630
3/30/90	1	<1	<5	<5	1	660
4/12/90	<1	<1	<5	<5	<1	—
4/27/90	<1	1	<5	<5	<1	600
6/28/90	<1	2	<5	<5	3	430
9/28/90	<1	<1	<5	<5	<1	300
Minimum	<1	<1	<5	<5	<1	270
Median	<1	<1	<5	<5	<1	520
Maximum	2	2	<5	5	3	670
Count	22	22	22	22	21	20

of freshwater aquatic life. The EPA criteria for these elements are to be adjusted based on the hardness of the analyzed water with increasing hardness increasing the criteria. Values listed in Table 6 are based on a hardness of 40 mg/L. Table 3A in Appendix A shows that median water hardness exceeds 500 mg/L at Hills Ferry. The criteria adjusted for hardness were never exceeded. Like chromium, however, the dissolved concentrations were all at or near the detection level for nickel, zinc, and copper. In no instance did the levels measured exceed the EPA guidelines for protection of freshwater aquatic life.

The water quality objectives adopted for the San Joaquin River (Table 5) are based on total recoverable concentrations for boron, selenium, and molybdenum. Testing on all three trace elements in San Joaquin River water shows no difference between dissolved and total recoverable indicating that sediment plays an insignificant role in the concentrations measured by the total recoverable methods. The data presented in Table 7 and in Table 3A in Appendix A shows for chromium, copper, lead, nickel, and zinc, that sediment plays a key role in total recoverable concentrations and dissolved values may better represent environmental exposure in the water column.

## COMPLIANCE WITH OBJECTIVES

In December 1988, the Regional Board adopted water quality objectives for the San Joaquin River. Various compliance dates were established for concentrations of selenium, molybdenum, and boron (Table 5). These objectives and compliance dates were to be effective with the Regional Board adoption and approval of the objectives by the State Water Resources Control Board, (State Board). State Board approved the objectives and compliance dates in September 1989, just prior to WY 90.

Two objectives for molybdenum apply to the San Joaquin River (Table 5). One objective applies upstream of the Merced River inflow, the second applies downstream of this point. Downstream of the Merced River inflow, as shown in Figure 10, mean monthly molybdenum concentrations were consistently below the adopted water quality objectives of 10  $\mu\text{g/L}$  for this reach of the river. This same pattern of compliance can be seen at the Hills Ferry site above the Merced River inflow where the adopted water quality objective is 19  $\mu\text{g/L}$  as a maximum monthly mean (Figure 11). As was also seen in WY 89, the maximum monthly mean was exceeded six months of WY 90 (Figure 11) at the Lander Avenue site, which is upstream of the drainage inflows. This period of noncompliance is the result of natural conditions that may be modified as a result of WY 90 being a critically dry year, the fourth such in succession. During WY 90, flows at the Lander Avenue site were very low and most flow resulted from ground water seepage.

In contrast to the elevated molybdenum concentrations at the Lander Avenue site, all monthly means for boron were less than or near 0.50 mg/L. Downstream of the drainage water inflows, boron concentrations at both the Fremont Ford and Hills Ferry Road sites increased significantly. Figure 12 shows the mean monthly boron concentrations as compared to the adopted water quality objective (Table 5), which is expected to be fully implemented by October 1993 (WY 94). This 2.0 mg/L objective was frequently exceeded during WY 90, although the objective only applies during the irrigation season (15 March through 15 September).

Downstream of the Merced River inflow, a different set of water quality objectives apply. These objectives are seasonal as well as being modified based upon critically dry water years. No provision was made for consecutive critically dry years. WY 90 is the fourth consecutive critically dry year. Figure 13 shows that the 1.3 mg/L boron objective was equaled or exceeded in 7 of the 12 months in WY 90 at Crows Landing Bridge. These high concentrations reflect the critically dry conditions in the river and the lack of dilution water for the subsurface tile drainage discharges. The current exceedences are in contrast to WY 89 where only one month exceeded the critical year objective.

Water quality objectives for selenium were also approved by the State Board. These objectives, like boron, vary with the location in the river and the type of water year (Table 5). In addition to the approved objectives the following milestones were used to assess progress towards meeting the selenium water quality objectives in the San Joaquin River.

Figure 10. Mean Monthly Molybdenum Concentrations at Crows Landing (Site Index D) and Airport Way (Site Index H) for WY 90 as Compared to the Adopted Water Quality Objective for the San Joaquin River Downstream of the Merced River Inflow.

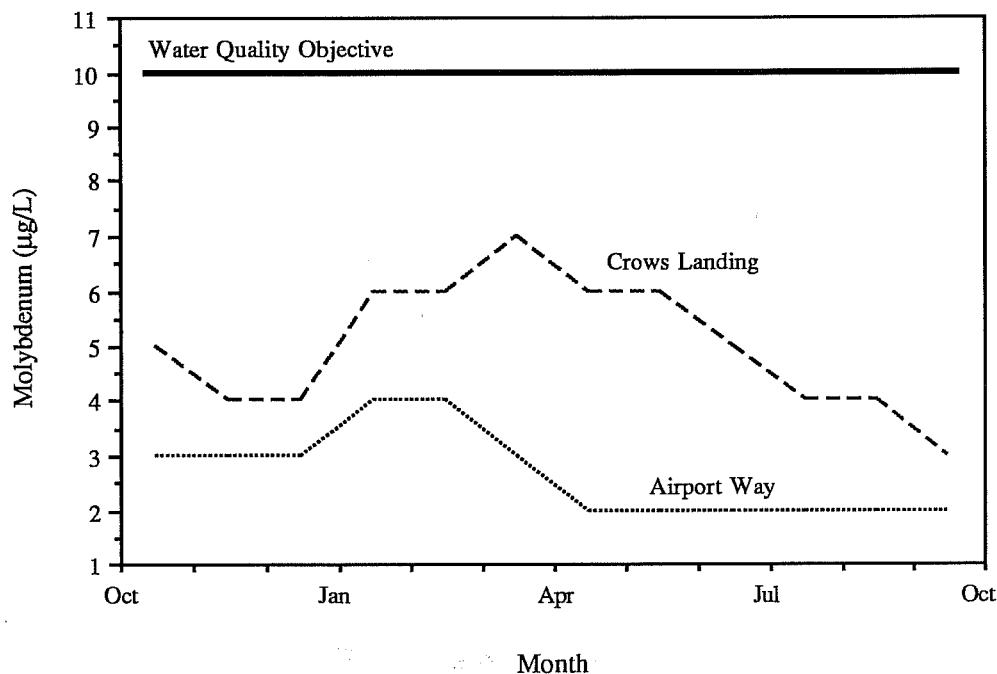


Figure 11. Mean Monthly Molybdenum Concentrations at Lander Avenue (Site Index A) and Hills Ferry (Site Index C) for WY 90 as Compared to the Adopted Water Quality Objective for the San Joaquin River Upstream of the Merced River Inflow.

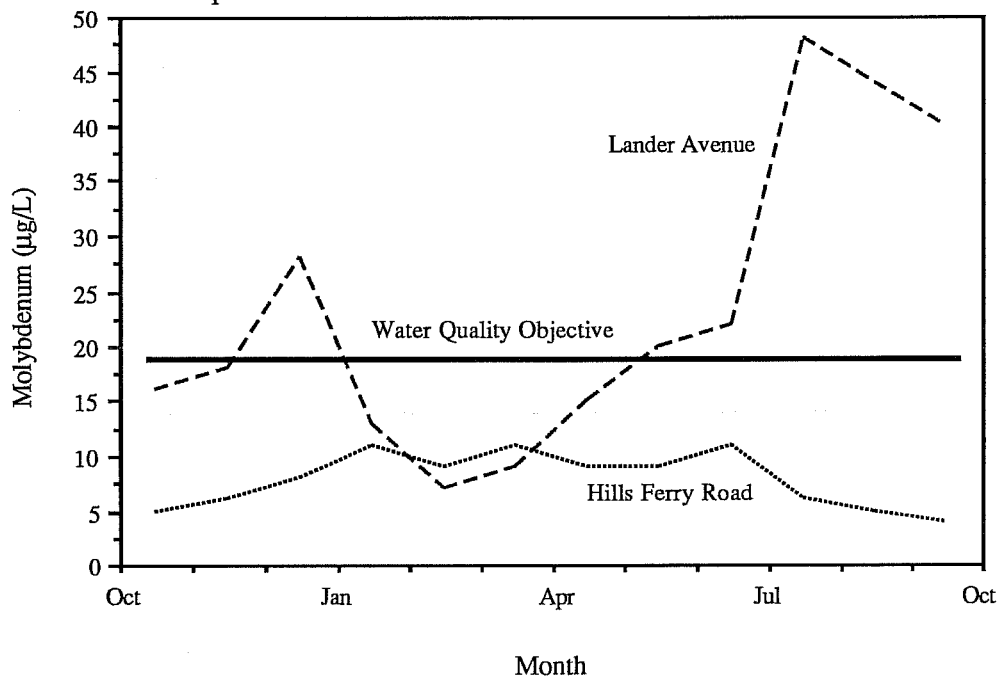


Figure 12. Mean Monthly Boron Concentrations at Freemont Ford (Site Index B) and Hills Ferry (Site Index C) for WY 90 as Compared to the Adopted Water Quality Objective for the San Joaquin River Upstream of the Merced River Inflow.

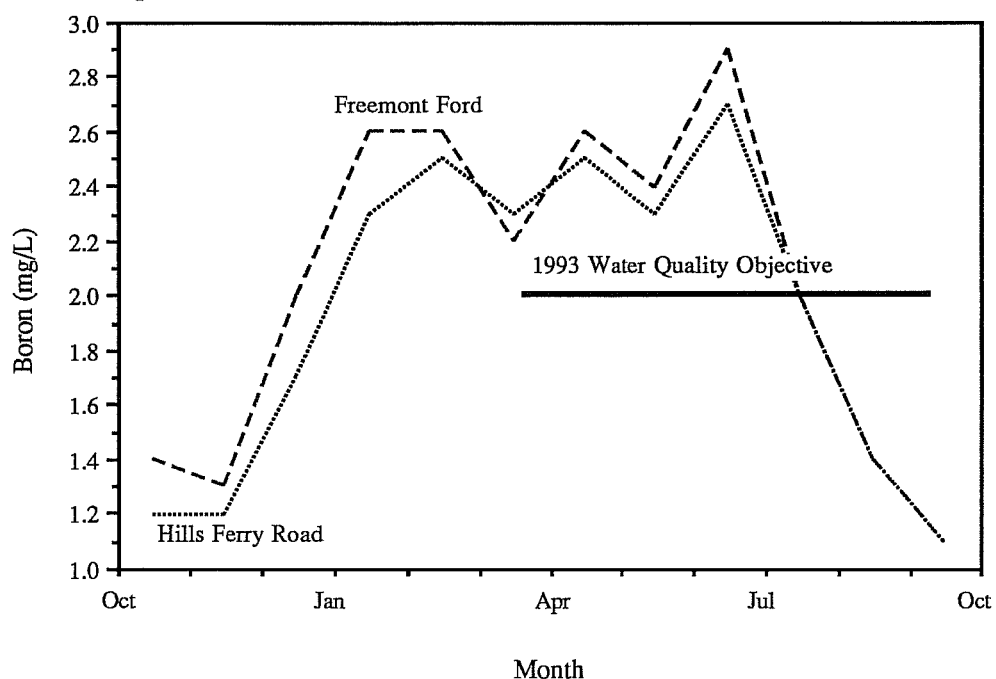


Figure 13. Mean Monthly Boron Concentrations at Crows Landing (Site Index D) and Airport Way (Site Index H) for WY 90 as Compared to the Adopted Water Quality Objective for the San Joaquin River Downstream of the Merced River Inflow.

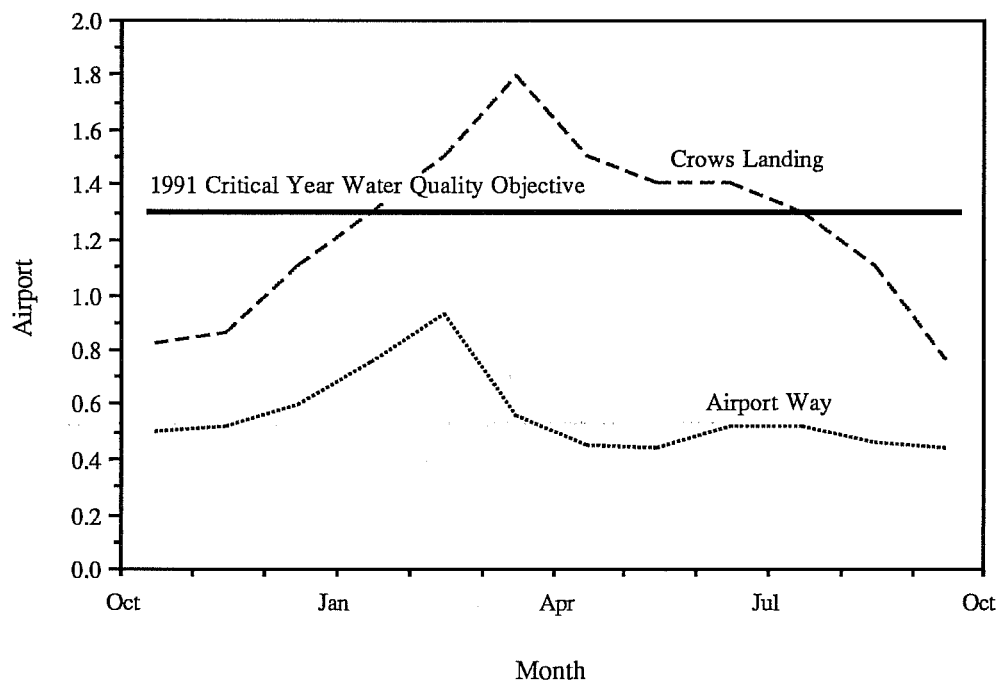


Figure 14. Mean Monthly Selenium Concentrations at Freemont Ford (Site Index B) and Hills Ferry (Site Index C) for WY 90 as Compared to the Adopted Water Quality Objective for the San Joaquin River and Milestones Established to Measure Progress Toward Meeting Objectives.

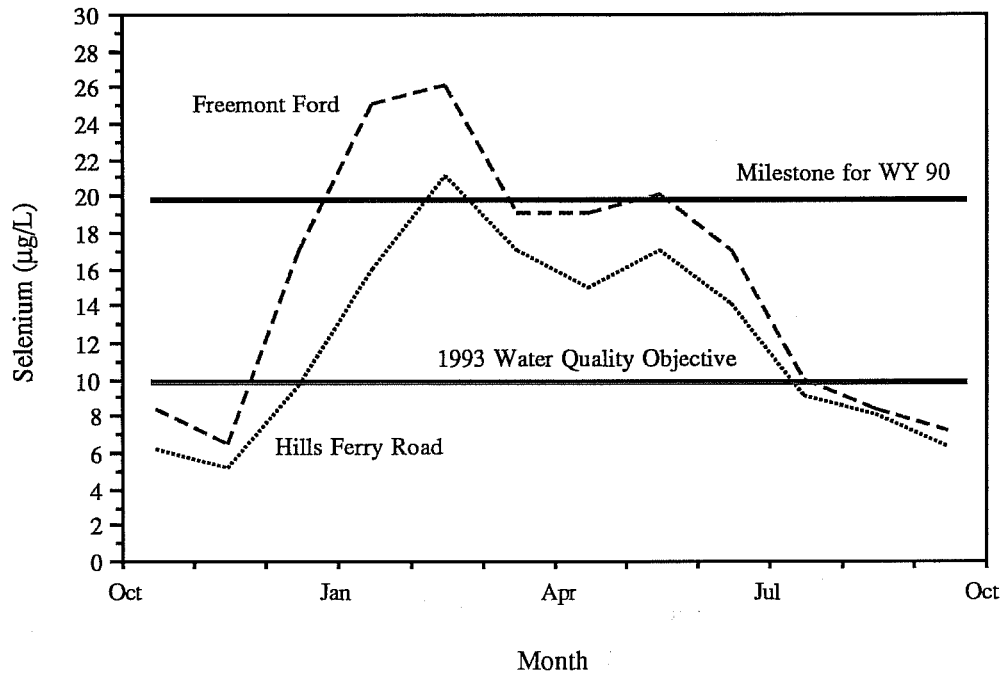
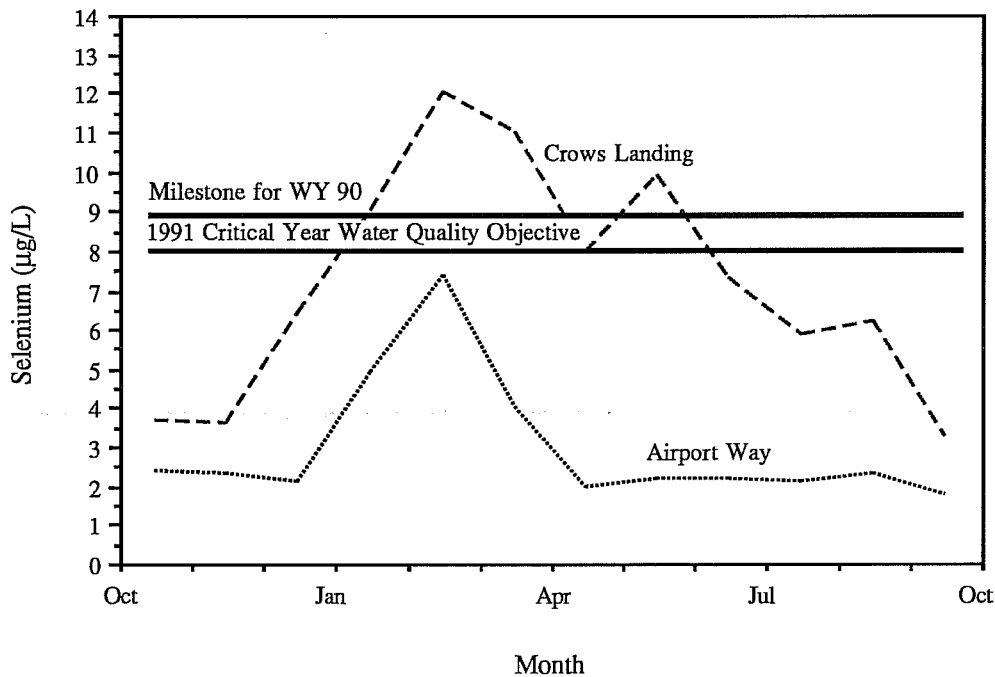


Figure 15. Mean Monthly Selenium Concentrations at Crows Landing (Site Index D) and Airport Way (Site Index H) for WY 90 as Compared to the Adopted Water Quality Objective for the San Joaquin River and Milestones Established to Measure Progress Toward Meeting Objectives.



### Maximum Monthly Mean Selenium Concentrations

<u>Time Period</u>	<u>San Joaquin River Mouth of the Merced River to Vernalis</u>	<u>San Joaquin River, Sack Dam to mouth of the Merced River</u>
WY 90 (10/89-9/90)	Dry Year* 6 $\mu\text{g/L}$ Critical Year* 9 $\mu\text{g/L}$	20 $\mu\text{g/L}$
WY 91 (10/90-9/91)	Dry Year* 5 $\mu\text{g/L}$ Critical Year* 8 $\mu\text{g/L}$	17 $\mu\text{g/L}$
WY 92 (10/91-9/92)	Dry Year* 5 $\mu\text{g/L}$ Critical Year* 8 $\mu\text{g/L}$	15 $\mu\text{g/L}$

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\* Type of water year as defined in "Water Quality Control Plan for the San Joaquin Basin (5C)", 1975

As with WY 89, in WY 90 the Lander Avenue site never had selenium concentrations that exceeded 2.0  $\mu\text{g/L}$  with all monthly mean concentrations being less than 1  $\mu\text{g/L}$ . This site is upstream of the subsurface tile drainage discharges to the river. Downstream of Lander Avenue, the discharges enter the river. Two monitoring sites exist below this point and prior to the Merced River inflow; they are Fremont Ford and Hills Ferry Road. Figure 14 shows the elevated selenium concentrations at these sites as compared to the adopted water quality objectives of 10  $\mu\text{g/L}$ . Full implementation of this objective is not planned until 1993; however, Figure 14 also shows the mean monthly concentrations as compared to the milestones outlined earlier. At these sites, only a few months exceeded the milestone, principally during the nonirrigation season when little dilution flow was in the river due to the fourth consecutive year of drought. The continued dry conditions are illustrated by the fact that at these two sites, the WY 90 milestone was not exceeded during the entire WY 89.

Downstream of the Merced River inflow, mean monthly selenium concentrations dropped as dilution inflows entered from the eastside streams. Figure 15 shows the monthly mean concentrations in comparison to the water quality objective for a critically dry year. This maximum monthly mean is to be fully implemented after October 1991 (WY 92). Also shown is the milestones set for WY 90. This milestone was exceeded in three months of WY 90. This continues to illustrate the critically dry conditions in the river for the fourth consecutive year and the need for further drainage flow reductions.

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## APPENDIX A

### Mineral and Trace Element Concentrations for Sites Along the Lower San Joaquin River in Water Year 1990 (1 October 1989 to 30 September 1990)

	<u>Page</u>
Lander Avenue (Hwy. 165)	A-1
Fremont Ford (Hwy. 140)	A-2
Hills Ferry Road	A-3
Crows Landing Road	A-5
Las Palmas Avenue (Patterson)	A-6
Grayson Road	A-7
Maze Blvd. (Hwy 132)	A-8
Airport Way (Vernalis)	A-9



Table 1A. Mineral and Trace Element Water Quality Data for San Joaquin River  
at Lander Avenue (site Index A) (MER522) for Water Year 1990.

Location: Latitude 37° 17' 43", Longitude 120° 51' 01". In NE 1/4, NE 1/4,  
Sec. 27, T.7S., R.10E. East bank, 50 ft. W of Lander Avenue  
(HWY 165), 2.3 mi. S of Stevinson. River mile 132.9.

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl mg/L	SO4	HDNS	Temp. °F
10/6/89	1355	7.8	1340	0.5	12	0.21	240	79	140	70
10/13/89	1215	7.8	1520	0.5	20	0.25	230	84	140	70
10/20/89	1305	7.6	1560	0.3	22	0.30	250	72	150	69
10/30/89	1145	7.3	1050	<0.2	10	0.12	170	60	170	60
11/6/89	1235	7.6	1080	0.3	16	0.18	160	62	140	60
11/13/89	1310	8.0	950	0.3	15	0.16	110	50	110	60
11/20/89	1025	7.2	1070	0.4	18	0.19	150	55	140	56
11/30/89	1215	8.1	1240	0.3	24	0.23	150	54	100	54
12/8/89	1150	8.4	1380	0.3	29	0.26	200	66	150	49
12/15/89	1150	8.7	1460	0.3	30	0.26	220	72	100	48
12/21/89	930	7.5	1210	0.6		0.21	160	59	120	43
12/29/89	1235	8.0	1240	0.3	25	0.23	200	69	130	44
1/5/90	1059	8.0	1320	0.2	24	0.24	180	66	150	44
1/11/90	1135	8.2	1330	0.7	13	0.25	220	97	220	44
1/19/90	1010	8.1	1500	<0.2	9	0.24	280	130	280	48
1/26/90	925	8.1	1220	1.4	7	0.17	140	67	280	50
2/2/90	1200	7.8	1220	1.3	12	0.19	180	110	330	50
2/9/90	1205	7.6	1090	0.7	9	0.25	150	92	190	50
2/19/90	1500	8.6	910	1.0	4	0.22	160	82	200	48
2/26/90	1200	8.1	440	0.4	3	0.10	49	35	110	
3/5/90	1240	8.4	990	0.6	6	0.23	160	100	220	
3/9/90	1235	8.2	1330	1.7	7	0.28	200	150	340	60
3/16/90	1313	8.8	1620	1.5	8	0.34	250	190	400	68
3/23/90	1250	7.1	1550	1.3	10	0.33	240	160	360	68
3/30/90	1015	8.6	1660	1.5	12	0.34	310	190	370	66
4/6/90	1210	8.4	1970	0.8	14	0.34				72
4/12/90	1122	8.7	2080	0.8	15	0.36				70
4/20/90	1120	8.1	2000	0.4	15	0.37				67
4/27/90	1100	8.3	2120	0.3	17	0.38	420	200	360	73
5/4/90	1150	8.4	2090	0.4	22	0.43				83
5/11/90	1110	8.4	2090	0.4	22	0.41				72
5/18/90	1150	8.4	2100	0.3	25	0.40				72
5/25/90	930	8.1	2310	0.3	27	0.38				69
5/31/90	1350	8.4	810	0.3	5	0.09	130	60	150	72
6/8/90	830	8.5	1370	0.4	13	0.23				75
6/15/90	1015	8.3	1500	0.4	17	0.30				73
6/22/90	1025	8.3	1880	0.3	26	0.33				82
6/28/90	930	9.4	1850	0.2	33	0.38	390	110	200	74
7/6/90	1030	9.7	2430	0.3	43	0.52				77
7/13/90	939	9.8	2590	0.4	49	0.62				82
7/20/90	953	9.9	2700	0.3	52	0.64				81
7/27/90	1225	9.9	2670	0.1	49	0.66	500	110	130	82
8/3/90	930	9.9	2760	0.3	56	0.66				78
8/9/90	1155	8.6	2900	0.2	59	0.69				86
8/16/90	1115	9.7	2940	0.2	59	0.67				80
8/24/90	1030	8.6	2190	0.5	27	0.43				75
8/31/90	755	9.0	1690	0.8	20	0.37	290	140	210	73
9/7/90	1110	8.4	1340	0.3	26	0.43	390	280	190	73
9/14/90	1120	8.8	1220	0.2	37	0.54				76
9/21/90	730	8.3	1330	0.8	44	0.58				68
9/28/90				0.3	53	0.58				
MIN		7.1	440	<0.2	3	0.09	49	35	100	43
MED		8.3	1500	0.4	20	0.33	200	83	180	70
MAX		9.9	2940	1.7	59	0.69	500	280	400	86
COUNT		50	50	51	50	51	31	31	31	48

Table 2A. Mineral and Trace Element Water Quality Data for San Joaquin River  
at Fremont Ford (site Index B) (MER538) for Water Year 1990.

Location: Latitude 37° 18' 34", Longitude 120° 55' 45". In NW 1/4, NW 1/4,  
Sec. 24, T.7S., R.9E. West bank at Fremont Ford State Recreation  
Area, 50 ft. S of HWY 140, 5.4 mi. NE of Gustine. River mile 125.2

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl mg/L	SO4	HDNS	Temp. °F
10/6/89	1405	7.8	1760	11		1.6	230	340	350	68
10/13/89	1145	7.7	1540	7.1		1.1	200	240	290	66
10/20/89	1235	6.5	1630	9.5		1.4	220	270	310	67
10/30/89	1215	7.5	1580	5.7		1.3	220	280	320	58
11/6/89	1250	7.8	1650	6.5		1.3	240	300	300	58
11/13/89	1200	7.4	1700	6.2		1.2	220	290	340	58
11/20/89	955	7.4	1850	6.8		1.4	260	330	340	53
11/30/89	1230	8.1	1810	5.9		1.3	240	290	330	50
12/8/89	1109	7.7	2220	11		1.9	330	450	450	48
12/15/89	1135	8.2	2050	11		1.7	280	390	390	44
12/21/89	940	7.5	2690	17		1.9	390	530	520	43
12/29/89	1215	7.9	2810	22	10	2.4	420	630	600	44
1/5/90	1043	8.0	2820	22		2.3	400	640	730	42
1/11/90	1103	8.0	3050	23		2.8	470	685	735	45
1/19/90	1145		2800	25		2.4	450	670	670	48
1/26/90	950	7.9	3060	31		2.9	510	790	700	49
2/2/90	1220	8.1	3070	33		2.9	430	730	780	50
2/9/90	1225	7.4	2810	24	9	2.6	370	700	560	50
2/19/90	1515	8.1	2420	27	8	2.2	340	550	510	48
2/26/90	1220	7.4	2380	19	7	2.5	310	530	550	
3/5/90	1250	7.9	2250	17	8	2.0	320	480	490	
3/9/90	1250	7.9	2640	20	11	2.2	360	530	580	60
3/16/90	1255	8.1	2680	22	9	2.4	370	540	610	62
3/23/90	1225	7.1	2530	15	9	2.0	380	470	560	67
3/30/90	1030	8.0	2950	23	10	2.5	430	640	640	64
4/6/90	1230	7.7	2960	23		2.6				68
4/12/90	1134	7.9	2670	14	9	2.1				70
4/20/90	1100	7.9	2440	14		2.6				65
4/27/90	1120	7.9	2970	20	8	2.5	480	650	730	
5/4/90	1140	7.9	2830	25	8	2.6				76
5/11/90	1035	8.1	2840	27	10	2.8				70
5/18/90	1205	8.1	2780	20	10	2.7				70
5/25/90	945	8.0	2460	16	7	2.4				65
5/31/90	1335	8.3	2030	13	7	1.6	300	440	450	70
6/8/90	730	7.9	2940	19	12	2.9				71
6/15/90	1030	8.1	3040	20	14	3.2				71
6/22/90	1050	8.1	2850	18	12	3.3				78
6/28/90	1645	9.5	1910	9.8	8	2.2	330	480	450	74
7/6/90	1010	9.3	1910	11		2.0				76
7/13/90	902	9.5	2400	14		2.8				80
7/20/90	1000	9.7	1520	7.2		1.4				78
7/27/90	1155	9.7	1750	9.4		1.8	240	350	380	80
8/3/90	945	9.7	2700	8.3		1.8				76
8/9/90	1125	8.2	1780	10	7	1.8				83
8/16/90	1125	10	1450	7.2	5	1.2				74
8/24/90	1040	7.6	1390	7.9	4	1.1				72
8/31/90	805	8.4	1430	8.4	4	1.1	190	280	330	71
9/7/90	1020	8.0	1510	9.4	5	1.3	220	320	350	70
9/14/90	1055	8.8	1310	4.4	5	0.82				70
9/21/90	740	8.0	1370	8.4	5	1.2				68
9/28/90	1100		1180	6.7		0.99	160	220	255	70
MIN		6.5	1180	4.4	4	0.82	160	220	255	42
MED		8.0	2400	14	8	2.0	320	480	490	68
MAX		10	3070	33	14	3.3	510	790	780	83
COUNT		49	51	51	27	51	32	32	32	48

Table 3A. Mineral and Trace Element Water Quality Data for San Joaquin River south of Hills Ferry Road  
(site Index C) (STC512) for Water Year 1990.

Location: Latitude 37° 20' 33", Longitude 120° 58' 38". In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T.7S., R.9E. West bank, 0.9 mi. SE of Hills Ferry road a abandoned tallow factory, immediately upstream of Merced River inflow, 3.3 mi. NE of Newman.River mile 118.1.

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	B	Cl	SO <sub>4</sub>	Ca	Mg	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	T.Alk	HDNS	TDS	Temp. °F
10/6/89	1440	7.9	1850	10	6	4	5	7	<5	11	1.3	240	350	80	40	230	5.4	<2	160	160	360	1100	69
10/13/89	1235	7.9	1550	5.5	5	6	11	11	<5	20	1.0	190	230	64	35	190	5.3	<2	150	150	290	890	68
10/20/89	1330	7.6	1520	6.3	5	5	12	10	<5	14	1.2	200	240	61	35	190	6.3	<2	160	160	290	870	67
10/30/89	1310	7.5	1380	2.7	5	5	11	9	<5	13	1.1	190	210	56	31	160	5.3	<2	160	160	270	800	58
11/6/89	1325	7.5	1630	5.6	6	4	13	12	<5	10	1.2	240	270	71	35	200	5.6	<2	170	170	300	970	58
11/13/89	1340	7.4	1690	5.1	6	5	9	8	<5	15	1.2	250	300	71	38	220	6.5	<2	180	180	320	1000	60
11/20/89	1050	7.6	1800	5.5	7	4	10	7	<5	12	1.2	220	240	66	37	220	7.3	<2	170	170	300	1200	55
11/30/89	1055	7.2	1690	4.0	5	3	5	5	<5	7	1.2	220	240	66	37	220	7.3	<2	170	170	300	1200	49
12/8/89	1215	8.0	1990	6.6	6	3	6	<5	<5	8	1.4	290	350	77	41	250	5.6	<2	190	190	400	1200	49
12/15/89	1035	8.2	1940	6.1	6	3	7	6	<5	6	1.5	290	360	75	41	270	6.4	<2	190	190	390	1200	44
12/21/89	1100	7.3	2390	9.6	2	2	5	<5	1	5	1.8	340	430	95	55	320	8.4	<2	210	210	450	1400	43
12/29/89	950	8.0	2493	13	9	<1	<1	<5	<5	<1	1.8	390	510	120	64	350	5.4	<2	200	200	500	1600	42
1/5/90	1000	8.0	2940	15	10	2	4	<5	<5	6	2.2	400	620	120	56	380	6.2	<2	210	210	650	1800	42
1/11/90	1023	7.8	2920	15	10	2	7	7	<5	14	2.3	480	640	130	73	410	7.4	<2	240	240	670	1900	45
1/19/90	1215	7.8	2550	14	11	2	4	6	<5	8	2.2	420	570	110	59	340	7.6	<2	210	210	540	1600	46
1/26/90	1040	8.0	3060	21	11	1	6	6	<5	9	2.6	530	710	140	72	420	7.4	<2	240	240	710	2100	50
2/2/90	1350	7.2	3140	26	9	2	11	10	<5	14	2.8	440	680	130	60	350	6.8	<2	220	220	710	2000	52
2/9/90	1300	8.1	2870	20	10	4	15	10	<5	13	2.5	380	670	140	66	410	6.8	<2	210	210	580	1900	50
2/19/90	1420	8.1	2630	21	9	3	12	10	<5	15	2.4	380	560	110	56	340	6.6	<2	210	210	520	1700	48
2/26/90				16	8	5	17	12	<5	15	2.4	330	520	130	58	330	7.6	<2	190	190	540	1600	
3/5/90	1325	7.4	2530	16	9	6	19	13	<5	19	2.2	350	550	120	51	370	6.2	<2	190	190	540	1600	
3/9/90	1330	8.0	2770	18	11	<1	<1	<5	<5	<1	2.2	390	560	130	64	360	7.2	<2	200	200	610	1800	60
3/16/90	1211	7.0	4120	17	10	2	10	6	<5	10	2.5	390	570	130	65	330	6.6	<2	200	200	630	1800	62
3/23/90	1140	7.2	2690	14	12	<1	<1	<5	<5	<1	2.0	380	490	130	65	360	6.2	<2	210	210	590	1700	68
3/30/90	1315		3080	19	11	3	10	7	<5	13	2.7	460	660	150	73	420	6.2	<2	210	210	660	1900	73
4/6/90	1320	7.8	3190	22	11						2.6	490	770								720		68
4/12/90	1339	7.9	2710	14	10		12				2.0												64
4/20/90	1000	8.0	2890	11	8	4	10	9	<5	16	2.8	460	590	130	72	410	6.6	<2	240	240	580	1700	65
4/27/90	1245	8.1	3160	12	8		27				2.2	470	580								600		74
5/4/90	1100	8.0	2810	18	8						2.2	470	680								640		76
5/11/90	940	8.0	2820	21	9						2.5	430	590								640		68
5/18/90	1240	8.2	2910	17	9						2.7	380	620								630		70
5/25/90	1025	8.2	2570	17	18	5	9	10	<5	19	2.4	270	370	100	48	270	7.5	<2	180	180	470	1400	66
5/31/90	1200	7.8	2170	13	8						1.7	310	440										70
6/8/90	710	7.8	2940	16	12						2.5	450	600								660		70
6/15/90	1100	8.4	3040	16	13						3.0	480	710								670		71
6/22/90	1130	7.9	2770	16	10						3.2	390	640								600		78
6/28/90	1035	7.9	2050	6.0	9	4	11	12	<5	30	2.1	430	430	89	44	250	6.4		170	170	430	1300	72
7/6/90	945	9.0	2030	11	6						2.1												73

Table 3A continued. Mineral and Trace Element Water Quality Data for San Joaquin River south of Hills Ferry Road  
(site Index C) (STC512) for Water Year 1990.

Location: Latitude 37° 20' 33", Longitude 120° 58' 38". In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T.7S., R.9E. West bank, 0.9 mi. SE of Hills Ferry road a abandoned tallow factory, immediately upstream of Merced River inflow, 3.3 mi. NE of Newman. River mile 118.1.

Date	Time	pH	EC µmhos/cm	µg/L							mg/L							TDS	Temp. °F				
				Se	Mo	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	Ca	Mg	Na	K			CO3	HCO3	T.A.Lk	HDNS
7/13/90	826	9.0	2310	11	8						2.4											80	
7/20/90	1045	9.3	1670	7.6	5						1.6											78	
7/27/90	1025	9.0	1730	6.7	5	4	9	13	<5	21	1.7	230	330	79	35	200	5.7	<2	180	180	370	1100	74
8/3/90	1020	9.4	3040	10	7						2.0											77	
8/9/90	1225	8.2	1780	10	6						1.8	250	390								370	86	
8/16/90	1220	9.2	1460	5.8	4						1.2	200	250								310	76	
8/24/90	1125	7.7	1460	6.4	5						1.0											74	
8/31/90	910	8.5	1570	7.8	5	4	6	7	<5	13	1.2	200	280	74	38	180	4.8	<2	190	160	350	960	71
9/7/90	935	8.0	1120	10	5						1.4	240	360	85	40	200	4.7	<2	190	160	370	1000	72
9/14/90	1300	8.7	1410	3.9	4						0.93											78	
9/21/90	900	8.0	1290	4.4	5						0.88	190	180								310	67	
9/28/90	945		1340	7.0	3	4	5	7	<5	13	1.0	170	230	62	34	160	4.6			140	300	810	69
MIN		7.0	1120	2.7	3	<1	<1	<5	<5	5	0.88	170	180	56	31	160	4.6	<2	150	140	270	800	42
MED		8.0	2490	11	8	4	10	7	<5	13	2.1	380	520	100	53	320	6.4	<2	190	190	540	1500	68
MAX		9.4	4120	26	18	6	27	13	1	30	3.2	530	770	150	73	420	8.4	<2	240	240	720	2100	86
COUNT		48	50	51	50	30	32	30	30	30	50	43	43	32	31	32	31	29	30	31	42	31	49

Table 4A. Mineral and Trace Element Water Quality Data for San Joaquin River  
at Crows Landing Road (site Index D) (STC504) for Water Year 1990.

Location: Latitude 37° 25' 55", Longitude 121° 00' 42", Sec. 8, T.6S., R.8E. West  
bank, 100 yds S of Crows Landing Road Bridge, 4.2 mi. NE of Crows  
Landing. River mile 107.1.

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl mg/L	SO4	HDNS	Temp. °F
10/6/89	1455	7.8	1550	5.9	6	0.99	190	270	300	68
10/13/89	1300	7.6	1200	4.0	3	0.67	140	170	230	66
10/20/89	1350	7.7	1210	2.1	4	0.76	160	170	230	67
10/30/89	1330	7.4	1220	2.8	5	0.87	170	180	270	58
11/6/89	1350	7.6	1320	3.9	5	0.89	190	220	260	58
11/13/89	1420	6.6	1260	2.9	4	0.80	170	200	240	60
11/20/89	1115	7.6	1300	3.9	4	0.86	170	200	230	54
11/30/89	1035	7.0	1280	3.5	4	0.89	160	180	240	49
12/8/89	1235	8.0	1340	3.9	4	0.85	190	210	270	49
12/15/89	1015	8.2	1450	5.5	4	1.0	210	250	280	44
12/21/89	1120	7.4	1590	5.8		1.1	220	270	300	44
12/29/89	920	7.9	1590	7.9	4	1.1	230	300	320	41
1/5/90	928	8.0	1780	8.4	6	1.2	230	340	365	42
1/11/90	1000	7.8	1870	9.3	5	1.3	290	360	400	45
1/19/90	1235	8.9	1710	7.2	7	1.2	260	360	370	48
1/26/90	1110	8.0	1990	11	7	1.5	320	430	470	50
2/2/90	1400	7.6	1820	13	6	1.4	250	370	360	50
2/9/90	1315	8.1	1900	12	6	1.6	240	400	380	51
2/19/90	1400	7.9	1780	12	5	1.5	240	355	350	50
2/26/90			1800	11	6	1.6	230	350	400	
3/5/90	1345	7.7	1900	12	7	1.7	260	390	410	
3/9/90	1345	7.9	1910	12	8	1.4	260	350	400	60
3/16/90	1145	7.9	1970	11	7	1.3	260	380	440	60
3/23/90	1115	7.3	1960	9.9	7	1.4	270	330	420	66
3/30/90	1250		2020	10	6	1.5	270	390	420	68
4/6/90	1340	7.7	1960	8.8	6	1.4				68
4/12/90	1400	8.0	1920	7.8	7	1.3				64
4/20/90	935	7.8	1970	8.6	6	1.7				64
4/27/90	1130		2030	6.5	6	1.3	250	340	380	
5/4/90	1040	8.4	1760	9.4	5	1.3				74
5/11/90	915	7.9	1780	10	5	1.4				68
5/18/90	1255	8.1	1940	12	6	1.6				70
5/25/90	1045	7.9	1890	11	8	1.5				67
5/31/90	1135	7.9	1520	7.2	6	1.0	230	280	320	70
6/8/90	645	7.5	1830	8.4	6	1.1				71
6/15/90	1125	8.2	1830	7.6	5	1.5				72
6/22/90	1150	8.0	1920	9.4	6	1.7				78
6/28/90	1025	7.9	1400	3.7	3	1.2	230	280	330	72
7/6/90	920	8.6	1560	6.8	4	1.4				72
7/13/90	800	9.1	1780	6.1	4	1.5				80
7/20/90	1105	9.1	1480	6.2	4	1.2				79
7/27/90	1005	9.0	1290	4.5	3	1.1	180	220	300	76
8/3/90	1040	9.3	1870	7.4	5	1.3				77
8/9/90	1245	8.0	1510	6.3	4	1.3				83
8/16/90	1225	9.2	1290	4.8	4	0.94				74
8/24/90	1150	7.7	1380	5.5	4	0.88				74
8/31/90	930	8.3	1590	6.8	4	1.2	190	280	360	70
9/7/90	900	7.6	1250	3.5	3	0.75	180	200	290	68
9/14/90	1315	8.6	1320	2.8	4	0.76	200	210	310	74
9/21/90	920	7.9	1200	1.6	2	0.74				68
9/28/90	920		1180	5.3	3	0.77	150	195	280	68
MIN		6.6	1180	1.6	2	0.67	140	170	230	41
MED		7.9	1710	7.2	5	1.2	230	280	325	68
MAX		9.3	2030	13	8	1.7	320	430	470	83
COUNT		47	51	51	50	51	33	33	33	48

Table 5A. Mineral and Trace Element Water Quality Data for San Joaquin River  
north of Patterson Bridge (Las Palmas Avenue) (site Index E) (STC507)  
for Water Year 1990.

Location: Latitude 37° 29' 52", Longitude 121° 04' 54". In SW 1/4, NW 1/4,  
SW 1/4, Sec. 15, T.5S., R.8E. West bank, 0.3 mi. N of Patterson  
Bridge at NE corner of Las Palmas Launching Facility parking lot,  
3.2 mi. NE of Patterson. River mile 98.6.

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl mg/L	SO4	HDNS	Temp. °F
10/30/89	1345	7.5	1060	1.7		0.67	160	160	250	59
11/30/89	1015	7.2	1270	3.3		0.84	150	170	230	50
12/29/89	850	7.8	1570	6.1		1.0	240	300	320	42
1/19/90	1250	9.4	1800	6.4		1.2	280	350	365	50
2/2/90	1430	7.5	1850	10		1.2	260	360	330	51
3/30/90	1230		2160	9.2	7	1.5	300	430	470	68
4/12/90	1436	7.9	1800	6.9	7	1.2				72
4/27/90	1100		2010	6.0		1.2	250	320	380	
5/31/90	1110	7.7	1340	4.5		0.81	200	230	310	70
6/28/90	1000	7.9	1400	4.0	4	1.1	250	360	440	72
7/27/90	940	8.9	1480	4.3		1.1	200	250	330	76
8/31/90	950	8.3	1700	4.6		0.93	210	275	390	72
9/28/90	905		1350	4.5		0.77	170	210	310	68
MIN		7.2	1060	1.7	4	0.67	150	160	230	42
MED		7.8	1530	4.6	6	1.1	225	288	330	68
MAX		9.4	2160	10	7	1.5	300	430	470	76
COUNT		10	13	13	3	13	12	12	12	12



Table 6A. Mineral and Trace Element Water Quality Data for San Joaquin River at Grayson Road, Laird Slough (site Index F) (STC511) for Water Year 1990.

Location: Latitude 37° 33' 43", Longitude 121° 09' 03". In NW 1/4, SE 1/4, NW 1/4, Sec. 25, T.4S., R.7E. Laird Park, 500 ft. S of Grayson Road Bridge, 1.5 mi. E of Grayson. River mile 89.1.

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl mg/L	SO4	HDNS	Temp. °F
10/30/89	1400	7.6	1260	3.0		0.76	180	170	280	60
11/30/89	950	7.4	1360	3.4		0.88	170	180	260	48
12/29/89	820	7.7	1670	6.6		1.0	250	290	340	42
1/19/90	1325	8.5	1840	6.0		1.2	285	360	415	50
2/2/90	1450	7.1	1850	10		1.2	270	340	360	51
3/30/90	1200		1850	7.3	6	1.2	260	330	510	66
4/12/90	1500	8.8	1590	4.1	4	0.88				72
4/27/90	1035		1900	5.3		1.1	240	280	390	
5/31/90	1050	7.9	1250	5.2		0.86	170	240	290	70
6/28/90	940	7.9	1400	2.9	4	0.92	220	260	340	71
7/27/90	915	8.9	1330	3.3		0.89	180	210	300	73
8/31/90	1010	8.2	1450	4.8		0.78	180	200	340	71
9/28/90	840		1290	3.4		0.66	170	180	310	67
MIN		7.1	1250	2.9	4	0.66	170	170	260	42
MED		7.9	1430	5.0	5	0.91	200	250	340	66
MAX		8.9	1900	10	6	1.2	285	360	510	73
COUNT		10	13	13	3	13	12	12	12	12

Table 7A. Mineral and Trace Element Water Quality Data for San Joaquin River  
at Maze Blvd., HWY 132 (site Index G) (STC510) for Water Year 1990.

Location: Latitude 37° 38' 31", Longitude 121° 13' 40". In SW 1/4, NW 1/4,  
SW 1/4, Sec. 29, T.3S., R.7E. West bank, 400 ft. S of Maze Blvd. Bridge,  
upstream of Blewett Drain, 5.7 mi NW of Grayson. River mile 77.2.

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl	SO4	HDNS	Temp. °F
10/30/89	1420	7.4	1000	1.7	3	0.56	140	130	230	59
11/30/89	925	7.2	1050	2.2		0.65	130	130	210	50
12/29/89	755	7.7	1290	4.5	3	0.74	190	210	260	42
1/19/90	1350	8.6	1520	6.3	5	0.91	235	290	370	51
2/2/90	1510	7.1	1490	7.2		0.89	220	250	290	51
2/9/90	1345	7.7	1470	8.9	4	1.0	190	270	290	51
2/19/90	1325	7.6	1430	9.8	3	1.1	190	260	290	48
2/26/90			1440	6.3	4	1.1	190	240	300	
3/5/90	1420	7.6	1590	7.6	6	1.2	210	290	330	
3/9/90	1420	7.8	1490	7.8	5	1.0	200	260	330	61
3/16/90	1110	7.7	1510	7.2	5	1.0	190	250	330	60
3/23/90	1020	7.4	1580	8.4	4	1.0	220	250	360	66
3/30/90	1140		1380	5.3	4	0.88	190	230	310	66
4/6/90	1430	7.7	1270	3.5		0.72				68
4/12/90	1520	8.0	1290	4.0	2	0.74				74
4/27/90	1015		1370	3.1		0.75	170	180	260	
5/4/90	1335	8.0	930	3.5		0.56				76
5/18/90	1600	7.9	1320	4.1		0.78				74
5/25/90	1130	8.1	1340	3.7	6	0.74				68
5/31/90	1025	8.0	1090	3.8		0.71	150	190	250	68
6/8/90	615	7.2	1470	4.4		0.89				68
6/15/90	1240	7.8	1640	6.2		1.0				76
6/22/90	1235	8.0	1390	3.8	2	0.84				78
6/28/90	920	8.1	1400	2.6	1	0.79	200	200	310	70
7/6/90	845	8.8	1380	4.0	2	0.91				70
7/13/90	722	9.1	1390	3.6	1	0.87				76
7/20/90	1145	9.0	1170	3.2	1	0.74				80
7/27/90	855	9.0	1100	2.3	2	0.68	160	150	270	74
8/3/90	1128	9.0	1260	4.0	1	0.79				78
8/9/90	1325	8.0	1230	4.0		0.85				83
8/16/90	1315	9.1	1170	2.8		0.66				76
8/24/90	1230	7.6	1220	4.0		0.70				76
8/31/90	1030	8.3	1200	3.3		0.67	160	170	300	71
9/14/90	1355	8.3	1150	1.8		0.55				74
9/21/90	950	7.7	1200	3.3	4	0.62				68
9/28/90	825		1070	3.1		0.55	150	140	250	68
MIN		7.1	930	1.7	1	0.55	130	130	210	42
MED		7.9	1340	4.0	4	0.79	190	230	290	68
MAX		9.1	1640	9.8	6	1.2	235	290	370	83
COUNT		32	36	36	21	36	19	19	19	33

Table 8A. Mineral and Trace Water Quality Data for San Joaquin River at  
Airport Way (site Index H) (SJC501) For Water Year 1990.

Location: Latitude 37° 40' 32", Longitude 121° 15' 51" . In SE 1/4, SW 1/4,  
NW 1/4, Sec. 13, T.3S., R.6E. West bank, 50 ft. S of Airport Way  
Bridge, 3.2 mi. NE of Vernalis. River mile 72.3

Date	Time	pH	EC µmhos/cm	Se µg/L	Mo	B	Cl mg/L	SO4	HDNS	Temp. °F
10/6/89	1540	7.6	1080	2.6	3	0.51	140	140	220	69
10/13/89	1340	7.6	1010	3.0	3	0.47	130	130	200	68
10/20/89	1440	7.6	870	2.2	2	0.50	120	110	190	65
10/30/89	1435	7.6	930	1.7		0.51	130	110	260	59
11/6/89	1430	7.8	960	2.4	3	0.54	140	130	190	59
11/13/89	1515	6.6	950	1.6	2	0.51	120	130	170	59
11/20/89	1150	7.9	950	2.7	2	0.49	140	130	210	55
11/30/89	900	6.6	920	2.3	3	0.53	120	110	190	51
12/8/89	1315	7.9	996	1.9	2	0.54	140	140	220	50
12/15/89	915	7.9	980	2.3	3	0.50	200	260	200	44
12/21/89	1240	7.8	1170	3.1		0.64	160	170	210	45
12/29/89	740	7.4	1200	0.8	4	0.66	180	180	250	42
1/5/90	838	8.0	1190	4.4	3	0.66	150	180	250	42
1/11/90	908	8.2	1230	4.8	3	0.73	170	200	250	45
1/19/90	1355		1350	4.9	5	0.77	200	230	310	51
1/26/90	1210	7.9	1340	5.4	3	0.83	230	240	350	53
2/2/90	1540	7.1	1330	6.0	3	0.76	180	210	270	51
2/9/90	1400	7.7	1370	7.6	4	0.89	170	250	270	51
2/19/90	1305	6.8	1290	9.6	3	0.96	170	230	260	48
2/26/90			1380	6.4	4	1.1	180	230	300	
3/5/90	1440	7.3	1170	5.4	4	0.87	160	210	240	
3/9/90	1440	7.9	1100	5.0	4	0.71	150	180	240	61
3/16/90	1045	7.4	720	3.3	4	0.37	81	100	160	58
3/23/90	955	7.4	720	3.9	2	0.41	89	100	170	63
3/30/90	1128		780	2.5	2	0.45	100	110	170	63
4/6/90	1450	7.7	870	2.0	2	0.45				68
4/12/90	1615	7.9	870	2.3	2	0.46				75
4/20/90	815	7.7	840	2.4	2	0.50				64
4/27/90	955		800	1.6	2	0.40	95	97	170	
5/4/90	1345	7.9	760	2.4	2	0.44				75
5/11/90	835	8.2	600	1.6	1	0.31				64
5/18/90	1615	8.1	900	2.2	2	0.44				72
5/25/90	1145	8.2	850	2.1	2	0.45				67
5/31/90	1010	7.2	920	2.9	2	0.56	130	150	220	66
6/8/90	600	7.0	990	2.7	2	0.52				70
6/15/90	1300	8.2	860	2.4	2	0.45				71
6/22/90	1250	8.2	1010	2.1	2	0.56				78
6/28/90	850	7.9	930	1.5	2	0.50	120	120	210	70
7/6/90	830	9.0	930	2.7	1	0.62				70
7/13/90	700	9.0	750	1.8	2	0.45				74
7/20/90	1200	9.2	830	2.2	1	0.51				78
7/27/90	835	9.2	850	1.6	2	0.50	130	110	210	72
8/3/90	1135	9.2	910	2.5	2	0.46				77
8/9/90	1345	7.9	890	2.4	2	0.52				80
8/16/90	1325	9.4	850	1.8	2	0.44				70
8/24/90	1245	7.5	870	2.6	1	0.44				76
8/31/90	1040	8.2	860	2.1	2	0.45	140	130	220	73
9/7/90	1245	8.2	910	1.8	2	0.44	140	120	220	71
9/14/90	1410	8.3	910	1.2	2	0.41				74
9/21/90	1010	7.7	930	2.3		0.44				69
9/28/90	810		920	2.0	2	0.46	130	120	220	66
MIN		6.6	600	0.75	1	0.31	81	97	160	42
MED		7.9	920	2.4	2	0.50	140	130	220	66
MAX		9.4	1380	9.6	5	1.1	230	260	350	80
COUNT		46	51	51	48	51	32	32	32	48



## APPENDIX B

Maximum, Minimum and Median Concentrations  
for Selected Mineral and Trace Elements  
for Sites Along the Lower San Joaquin River  
in Water Year 1990  
(1 October 1989 to 30 September 1990)

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Electrical Conductivity	B-1
Chloride	B-2
Sulfate	B-3
Boron	B-4
Selenium	B-5
Molybdenum	B-6



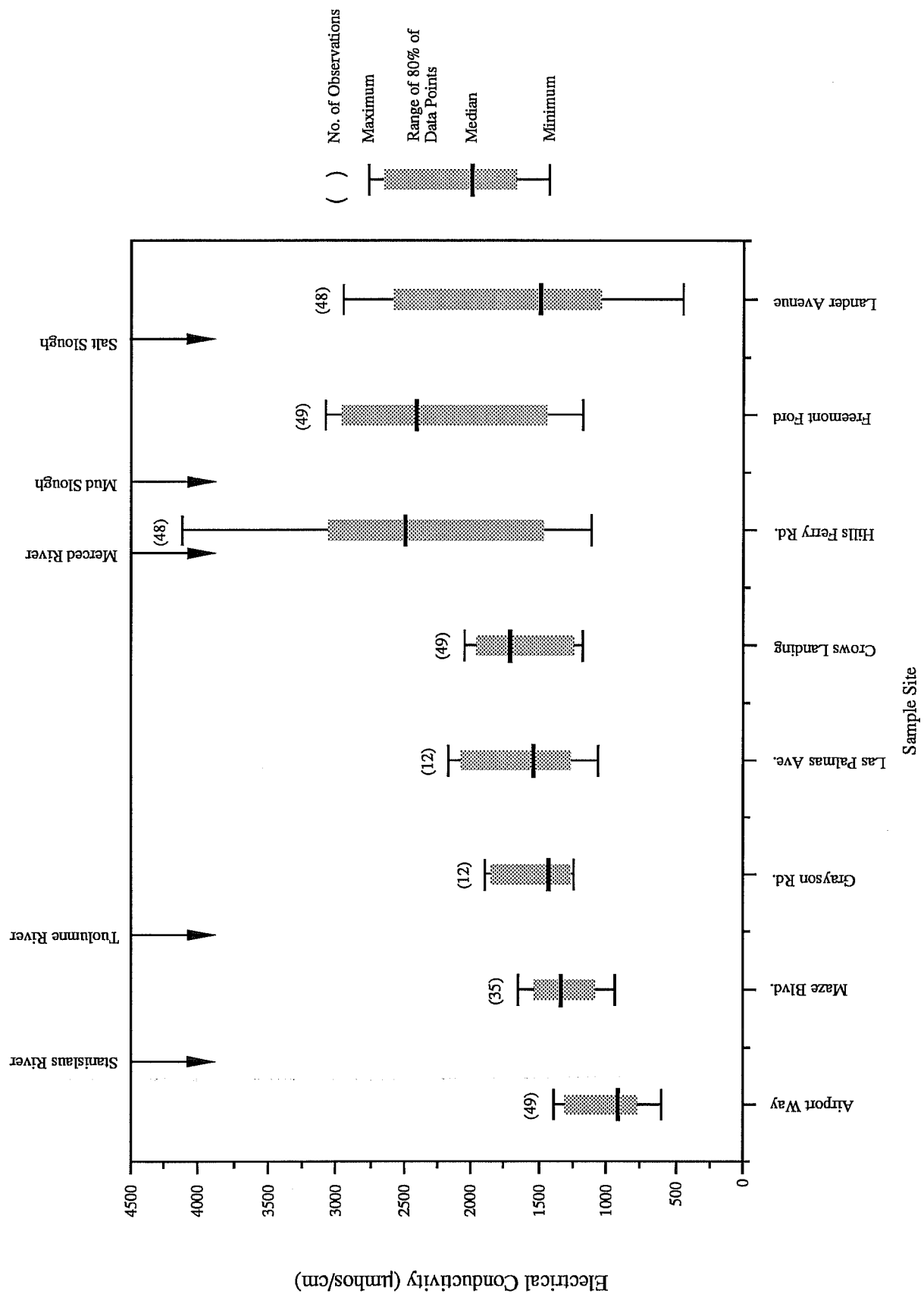


Figure 1B. San Joaquin River Electrical Conductivity Measurements for Water Year 1990; a Critical Water Year.

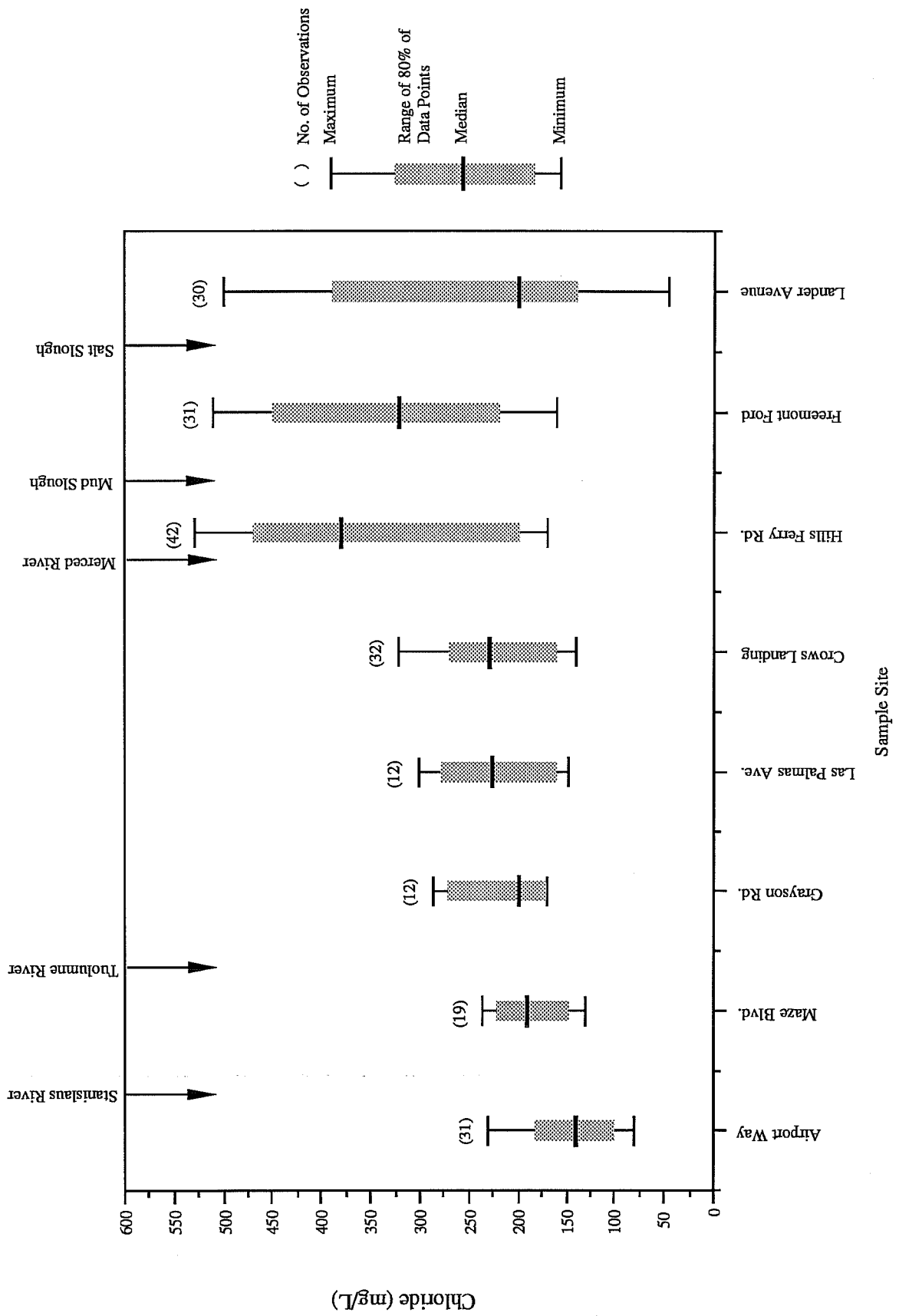


Figure 2B. San Joaquin River Chloride Measurements for Water Year 1990; a Critical Water Year.



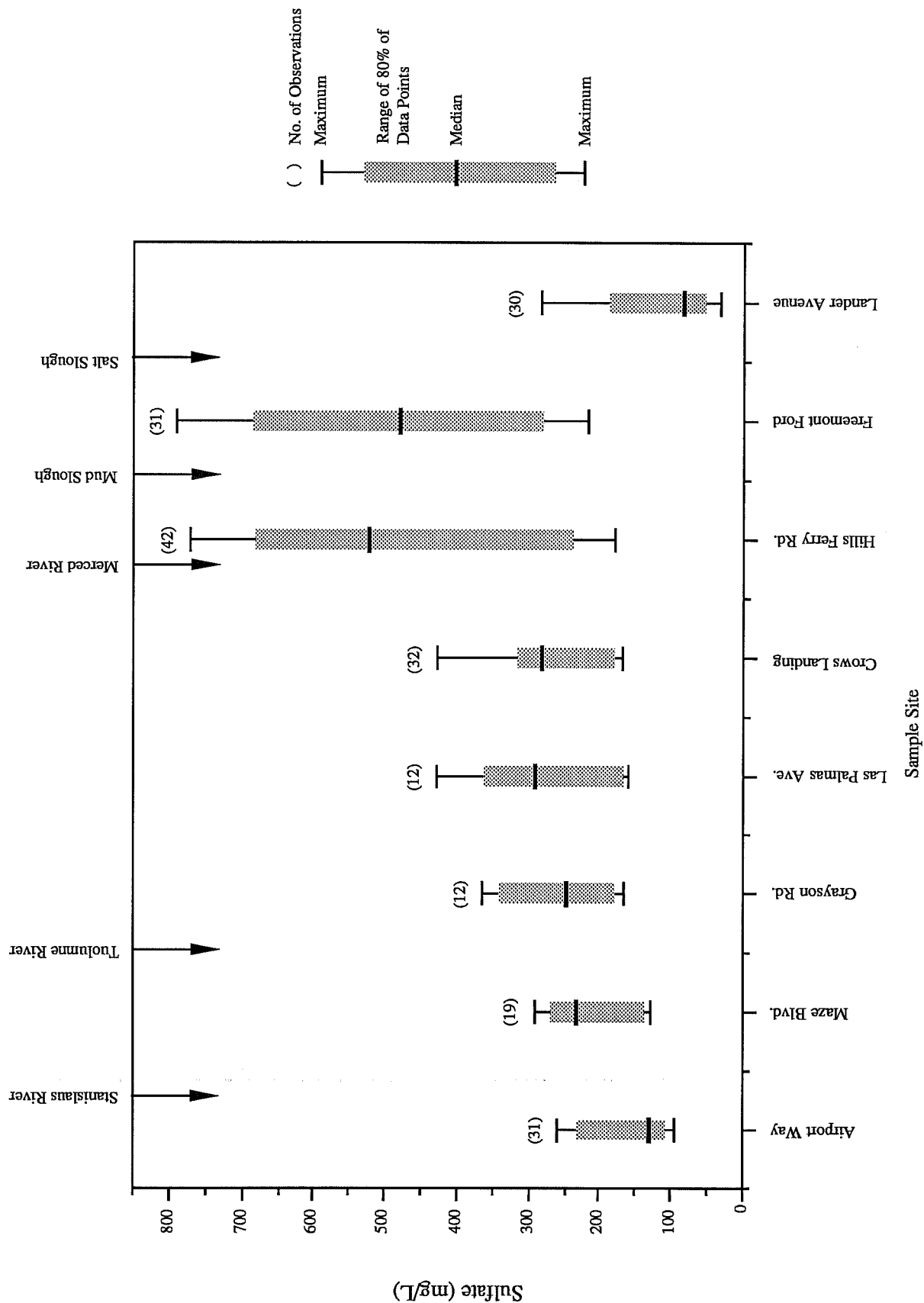


Figure 3B. San Joaquin River Sulfate Measurements for Water Year 1990; a Critical Water Year.

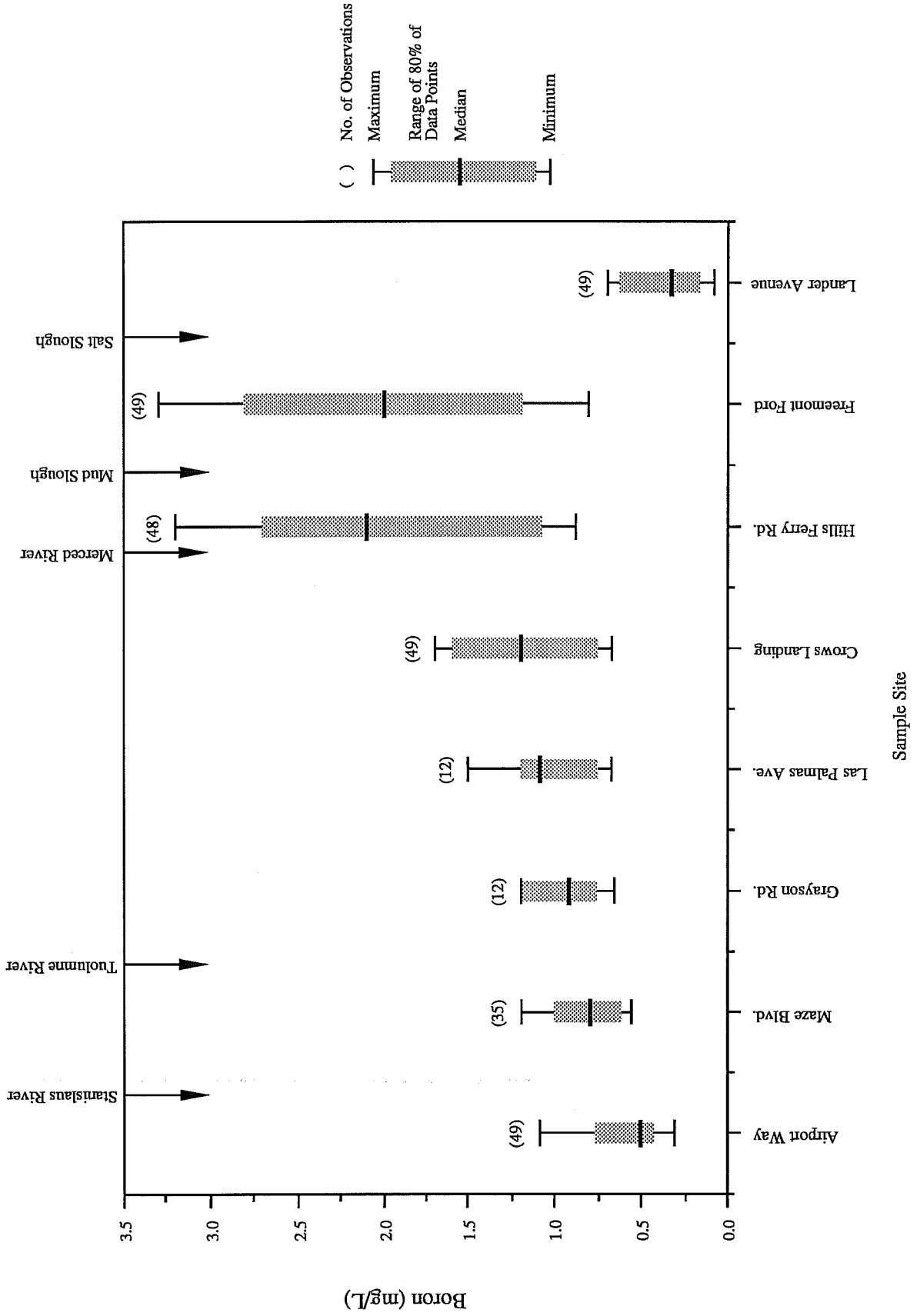


Figure 4B. San Joaquin River Boron Measurements for Water Year 1990; a Critical Water Year.

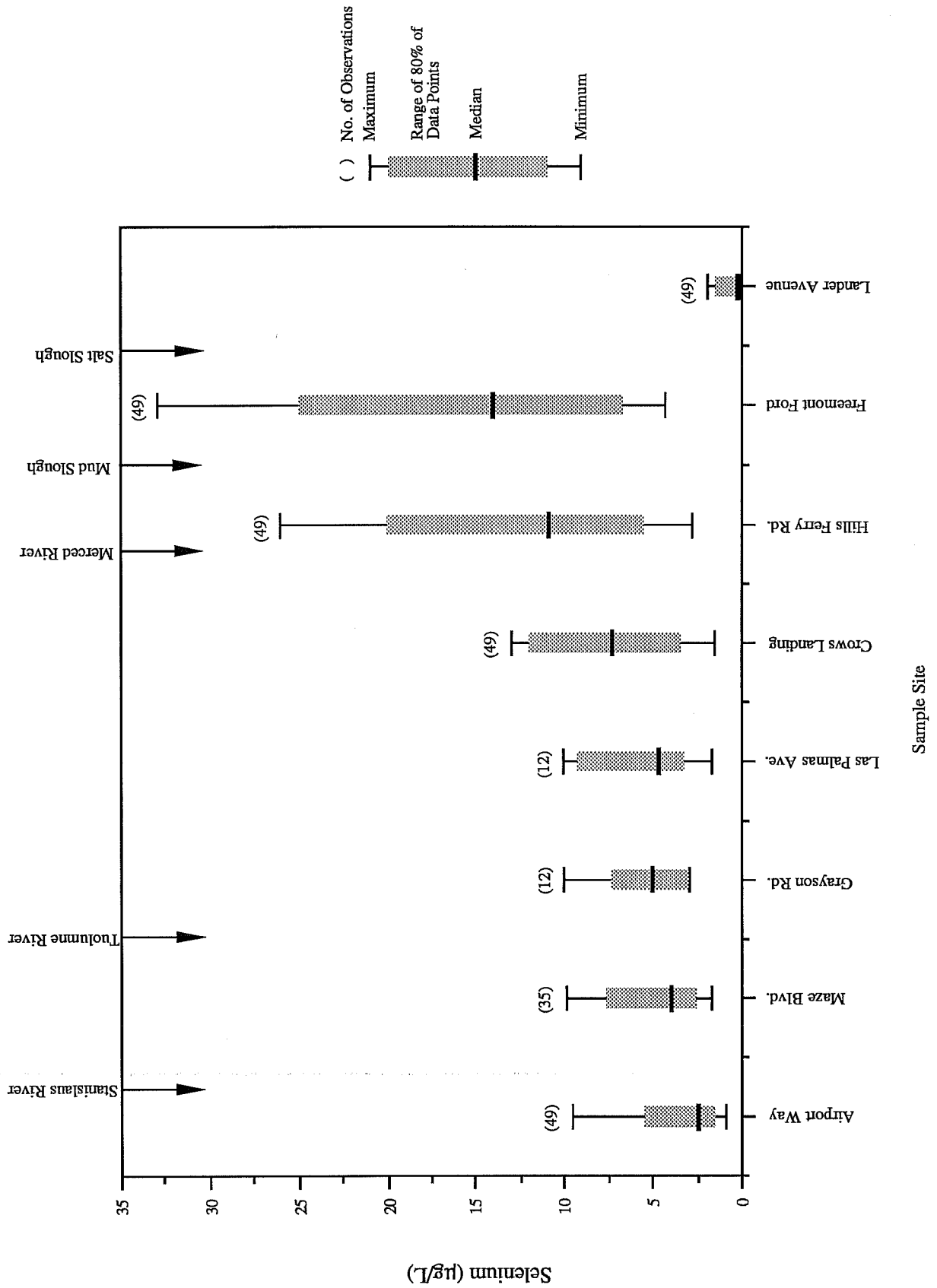


Figure 5B. San Joaquin River Selenium Measurements for Water Year 1990; a Critical Water Year.

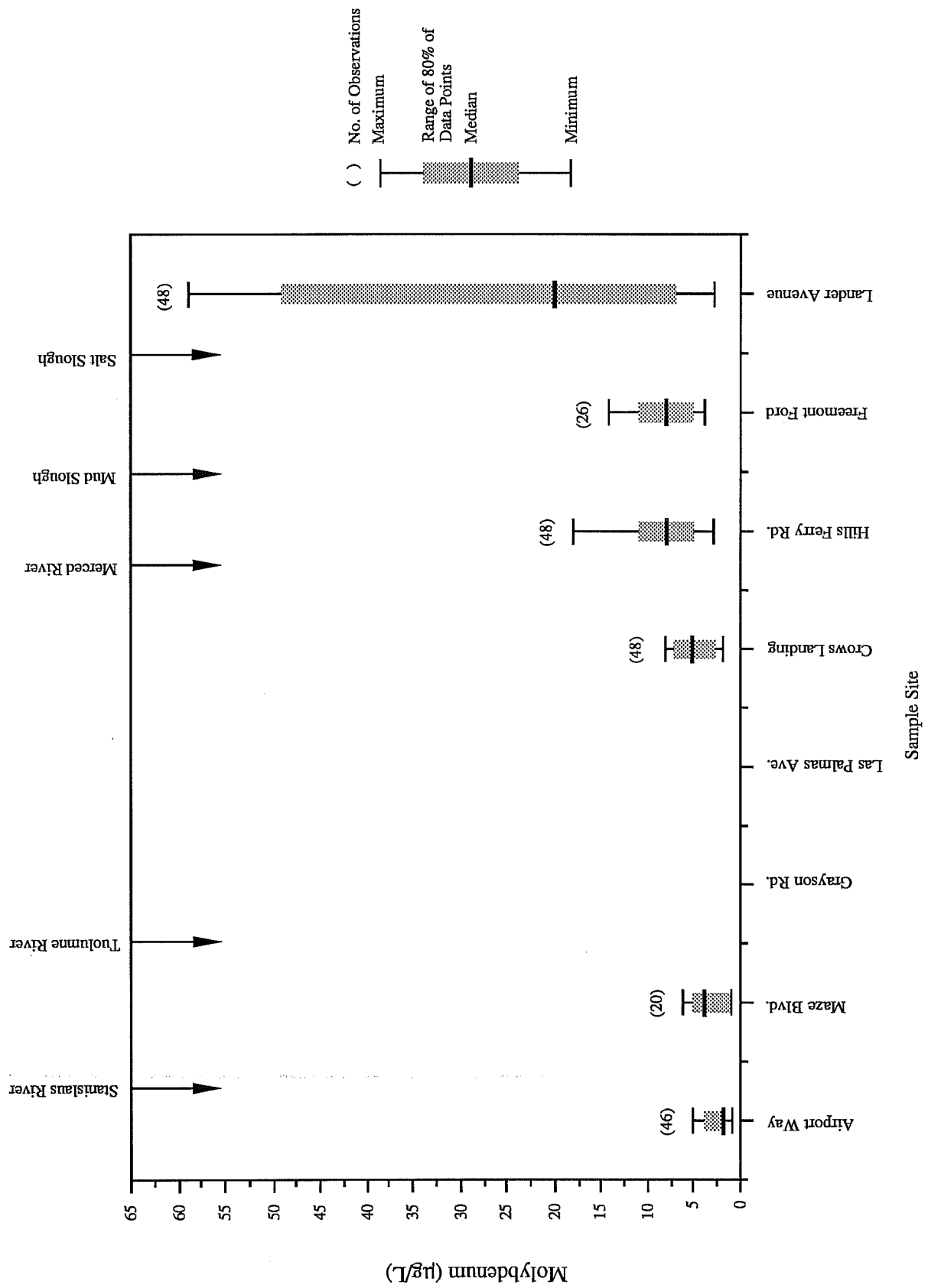


Figure 6B. San Joaquin River Molybdenum Measurements for Water Year 1990; a Critical Water Year.



